THE ENGINEERING MAGAZINE

VOL. XX. MARCH, 1901. No. 6.

THE COMING INDUSTRIAL EMPIRE OF PUGET SOUND.

By D. B. Bogle.

One of the most significant situations in the modern world is to be found on the northwest coast of North America. Vast deposits of iron and coal are just being developed by tireless Anglo-Saxon enterprise. Across the Pacific the enormous markets of the East are newly opened up. Wherever such conditions have existed, foci of industry have been created. Mr. Bogle sketches with authority and with admirable moderation the future promise of the cities of Pacific North America.—THE EDITORS.

NO estimate of the possibilities of development in every portion of the Pacific Coast of North America would be possible. It will be found, however, that from the point of view of industrial and commercial development the Pacific Coast is not indeed narrowed to, but is centralised in, a particular portion of it known generally as the Pacific Northwest. That term itself is one which requires some definition. It denotes a territory quite well-recognised as to its centre or nucleus, but not by any means so well-defined as to its boundaries. Its centre may be taken as that point on the Pacific Coast which represents the nearest economic shipping point to the Orient. This covers the southern portion of Vancouver Island, the coast of British Columbia on the Gulf of Georgia, and the seaboard of the United States on Puget Sound. The eastern boundary may be taken

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by continuing the eastern boundary of British Columbia southwards. This boundary, the watershed of the Rocky Mountains, is a natural boundary which really defines a territory differing in natural conditions from that adjoining it, and is not, like the dividing lines of the several states, or the 49th parallel itself, a mere conventional delimitation of territory. As to its northern and southern boundaries, they must be left still more indeterminate. To the south there exists somewhere a thermal line of enervation. Towards the north, on the other hand, the limits are set, not by the softness of nature, but by her rigors. In the light of recent discoveries it is necessary to speak respectfully of the frozen north. The Sunny South, indeed, levies a tribute on man's weakness by its continual invitation to a life of indolence and repose; but the north exacts too much from his strength, and browbeats his capacity to a level of uniformity with its own barren savagery and leaden gloom. All of which may be more shortly expressed by saying that the completest development, industrial and social, is only to be expected within the limits of the temperate zone.

When the development of a new country is considered, there are clearly different stages of development, at any one of which growth may be permanently arrested if the conditions are unfavourable for further evolution.

First comes what is known as the exploitation of its natural resources. Many parts of the world remain at this stage of development. They export raw material in order that they may purchase the finished products they require. Such parts of the world must always remain at the bottom of the scale. The whole course of American and Canadian progress has been a struggle to escape from this condition. It is quite possible that the eastern portions of both countries would view with equanimity the permanent condemnation of the west to this industrially subservient condition. But the same character of enterprise which has developed the industries of the eastern seaboard is reproduced upon the Pacific, and it will accomplish similar ultimate results.

The next important stage in development is the establishment of centres of distribution, where the raw produce of a country is collected and exchanged for the finished goods it consumes, instead of being drawn away direct from the separate places in which it is produced. Properly speaking, this is the function of that class of the community known as merchants. Mercantile communities are divided into two classes, those which provide a market for the raw home products, and import what is needed for the home population; and those which pro-

vide a market for the raw products of foreign countries, and supply them with what they require in exchange, whether of home production or derived from abroad. With this explanation, what is meant by the statement that the distributing centres for the Pacific Coast are, as yet, foreign points will be understood. The eastern nuclei of collection and distribution do more business in one week with the territory under consideration than the cities on the coast do in one year. The reason for this is that the territory needs nothing that comes from the Pacific Coast (whereas everything it does need comes from the eastern States) and produces nothing for which a market exists on the Pacific Coast. This fact will be found to have a most important bearing upon its future. There are exceptions, of course.

The next stage in a country's development is marked by the manufacture of the raw material produced in the country itself to supply the wants of its own population. But no country can remain very long in that condition provided it possesses any outlet at all. It must inevitably begin to supply the necessities of its less advanced neighbours; and lest it should stop short upon their necessities, will create in them various desires in order to satisfy them. It will buy their raw material and supply them with its manufactures, charging a high percentage on the value of the raw goods it purchases, which goes to remunerate its labour, increase its population, and add to its redundant stores of capital. Following upon that comes the financial control of its commercial tributaries, and the mortgaging of their natural instruments of production. But these three last stages are really one. There is no possibility of halting between one and the other of them, unless, indeed, a country by complete isolation is forced to remain at the first. In such a case it is assumed that the country has never had a market for its exports of raw material. Any country having an export trade in raw materials, and having reached the stage of manufacturing, must inevitably pass to the final stages of annexing the trade of commercially subservient territories and of possessing itself of financial domination over them. The limits of its greatness will be the limits of the territory it is thus able to control.

Certain facts may now be stated affecting the future of the Pacific Coast. The first of these is, that however rich it may be in natural resources the exploitation of these will never support a very large population, or build up great cities, so long as all the raw wealth produced is exported and all the finished products required are imported. The second of these facts is, that while a great trade may be built up

by way of the Pacific Coast with foreign countries, that of itself will not build up great cities on the coast, because modern commercial methods will prevent these cities being the sellers, purchasers, and changers of this commerce, and leave them in the condition of onlookers merely. Consequently, the future of the Pacific Coast, if it is to have any worthy of the name, is dependent on the manufacture of the raw materials produced within its limits and drawn from outside, to supply the wants of its own population and those of the available foreign territory. In other words, the Pacific Coast must have such a future as is connected with the history of the industrial, commercial, and financial supremacy of Great Britain during the nineteenth century, such a future as is visibly dawning for the United States, with its centre on the Atlantic seaboard, during the twentieth century—or it must remain forever in a condition of commercial subserviency. It must undergo a development co-ordinate with that of the Atlantic seaboard, although postponed to it in the matter of time, and deriving its dynamic force from a more or less separate commercial impulse.

This, then, must be the character of the development which will mark the future of the Pacific Coast; its extent depends upon conditions of a different nature. The first of these is the extent and variety of its natural wealth. It is quite true, as has been shown above, that no matter how rich and varied the resources of a country are, these of themselves will not give it a position of industrial or commercial supremacy, other conditions being absent; but it is equally true that no country can in this modern age attain to great commercial and industrial eminence unless it contains a great wealth of natural resources in itself, which, together with the extent of tributary territory it commands, will be the ultimate measure of its expansion.

After the extent and variety of natural resources, follow the possibilities of manufacturing finished products out of raw material at a maximum of economy compared with other manufacturing countries. Various questions are here raised. The transportation of raw material to an economic centre, the proximity of iron ore and coal, the availability of power, and the efficiency and cost of labour, are all most vitally important considerations.

Lastly, must come under review the nature and extent of the market it is proposed to supply, the wants it possesses at present, and those likely to be brought into being, as well as the goods it is able to give in exchange for what it purchases, and the availability of these goods to supply the wants of the manufacturing country or to be utilised by it in exchange with countries which can supply these wants.

It is evident that an enquiry into any one of these three conditions would extend far beyond any reasonable limits and that to exhaust all three in their bearing upon one another would be a futile task, because the future of the Pacific Coast would have become its past before the labour was completed. It is possible only to indicate in the barest way the extent to which those conditions, discovered to be necessary to a great commercial development, actually exist.

To begin with the natural resources of the Pacific Slope, these may be taken for granted. It is frequently said that this territory is not an agricultural country, except in portions of it which, relative to the whole, are insignificant. In the minds of those who say so the term agricultural is used, unconsciously, as describing a territory whose only resources are agricultural. In this sense, indeed, the Pacific Coast is not an agricultural country. It possesses plenty of agricultural land, but cannot, except in a few places, enter into competition with the prairies as an exporter of agricultural produce. Agriculture waits upon industry and population to provide an adjacent market; it does not call them into being. The salmon fisheries of the Pacific Coast are already the foundation of an important industry; its deep-sea fisheries, particularly in the more northern latitudes, are wonderfully rich and varied, but are not yet exploited to any large extent. Agriculture and fisheries are, however, unimportant to the present enquiry compared with the resources of the forest and the mine. It is beyond the limit of any merely human descriptive powers to do justice to the timber wealth of the Pacific Coast. It has been calculated with reference to British Columbia alone that at the present rate of consumption it would take 700 years to exhaust the more available supplies of timber; and as, under the husbandry of nature, forests will renew themselves in less time than 700 years, the calculation is merely a way of indicating that the timber resources of the Pacific Coast are practically inexhaustible. It is not too much to say, then, that for all trade and commerce into which wood and the products of wood enter, and for all manufactures in which wood and the products of wood are consumed, the Pacific Coast possesses resources incalculably greater than any other portion of the globe, civilised or uncivilised.

As regards the products of the mine, the territory under consideration already produces no inconsiderable proportion of the world's annual supply of gold, silver, copper, and lead. It is besides infinitely rich in iron, coal, and petroleum, of which its stores are hardly yet comprehended, much less utilised. And what is known of all its

mineral resources is as nothing in comparison with what is not known, or at most, merely indicated. An insignificant portion of the State of Idaho, for instance, produces one-third of the lead output of the United States; an inappreciable dot on the surface of British Columbia produces more lead annually than is consumed by the whole population and manufacturers of the Dominion of Canada. Copper is distributed over the whole area of the Pacific Slope. But it takes more capital, more elaborate transportation facilities, and more time to make copper mining pay than many people imagine, and consequently the area of production widens more slowly than that of gold, silver, or even lead, which, in less favoured districts, is frequently won in considerable quantities as a bye-product of silver. As for coal and petroleum, the latter has only begun to be looked for, the other is valueless unless on a line of railway or close to the seashore. Nor would a line of railway to a coal field be dreamt of unless there were a particular use for the fuel at the other end of the line. Iron ore is known to exist in almost limitless quantities, and that is all that is known about it. It awaits an available market for the products of iron, or, it would be more correct to say, the possibility of manufacturing these products in competition with other parts of the world. In two metals only is this territory deficient—nickel and tin; the latter disability it shares with the whole of North America, the former with all of it except the Canadian province of Ontario.

The iron resources of the Pacific Coast naturally introduce the question of the possibility of competition in manufactures with other parts of the world. So far as natural conditions for the manufactures of iron go, they could not be improved upon. One of the largest and most valuable known deposits of iron in this whole region exists on an island, and, dipping under the sea, reappears on the mainland adjacent to the seashore. At the most important coal mines the bunkers of ships are filled from the pit mouth. The requisites for economical reduction could not be more amply fulfilled. And, in addition, no metals except tin and nickel, which enter into the simplest as well as the most complex manufacture of iron, but are produced within the limits of the territory under consideration, and are produceable there in larger quantities (and therefore ultimately at less cost) than anywhere else. Another point, which is of great importance, has seldom had drawn to it the attention it deserves. Anyone who will take the trouble to examine a contour of the North American continent, delineated from east to west, will observe a gradual elevation from plateau to plateau to the great watershed of the Cordilleran range, and

then a series of swift and steep declensions until the water line of the Pacific Ocean is arrived at. The same excessive humidity which has clothed the Pacific Slope in the temperate zone with inexhaustible forests, makes those mountain ranges vast reservoirs of water, of which the overplus plunges down in a thousand cataracts to the sea, forming an available source of power unexcelled, and probably not even approached, in any portion of the world. In all this territory it would not only be unnecessary—it would be almost impossible—to establish any manufacturing industry beyond the radial limit of electrical energy generated by water.

The question is immediately raised: If all these things are so, why is it that the Pacific Coast in its northwestern centre is not already the manufacturing centre of the world? I suppose this question could be answered by a minute investigation into these laws of commercial and industrial relations which are at once the fascination and despair of economic thinkers—elusive as are the laws of growth and of the influence of environment upon potential development, to the biologist. It is shorter, easier, and ultimately just as satisfactory to recognise that an egg is not a chicken, and that an acorn is not an oak. At the same time, there are certain considerations, plainly to be discerned on the surface of things as it were, which indicate that industry does not spring forth like a fully armed goddess, but is developed by a series of movements infinitely minute. A further consideration is that any finished product of the more complex manufactures requires, as raw material, a multiplicity of things which are, in reference to the raw materials out of which they are constructed, themselves the completion of a manufacturing process or of many such processes. The calling together of all these industries at once cannot be conceived of, let alone accomplished. Long years of patient development are required before the action and reaction of market and opportunity admit of their consummation in a lucrative and fully developed trade. Most important of all, the labour cost of any article of manufacture is greater in the west than in the east. This difficulty in competitive production, if it may be so called, has been overcome in very many branches of manufacture in the United States, first, by the increased intelligence and therefore increased productivity naturally developed in more highly paid labour, and second, by the enforced application of genius to the invention of labour-saving contrivances. So that, while the remuneration of labour is greater, the labour cost of manufactures is not greater; in fact, through the superior natural resources of the country, and those causes affecting labour already mentioned, the total

cost of manufactures is in many cases reduced. It may be most reasonably asked why it is that the price of labour is higher in the west than in the east, when population is left perfectly free to move from the one to the other, just as indeed population is practically free to move from Europe to America. The reason is that a new country is only able to absorb population gradually as its resources are opened up; so that, while it offers greater opportunities to the individual who can gain a footing in it, to the mass it offers neither wealth which it is in their power to exploit nor a market in which they can sell their labour. Later on, when this disability has been removed, the disparity is fixed by the higher productivity and intelligence of the labour developed in the newer and richer country. This is the explanation of the fact, often commented on, that the American mechanic does a better day's work than his European brother. Nor must it be forgotten that the enhanced opportunities offered by a new country are purchased by a corresponding amount of hardship, and loss of what may be called the communal enjoyments of civilisation. How largely these bulk in human life let those judge who have been condemned for longer or shorter periods to forego them.

Whether or not there will be a permanently higher rate of remuneration for labour in the west of America than there is in the east, one thing is certain—that the industrial and commercial development of the Pacific Coast is postponed until the labour cost of the articles produced is as low as, or lower than, it is in other parts of the world. Or, it would be more correct to say, since such development is brought about by infinitesimal progressive steps, that its full equality or superiority is so postponed. The first products in which the Pacific Coast will gain pre-eminence will be those separated from the bare raw material by the simplest manufacturing process. In these products the labour cost bears a smaller relation to their value than in more complicated manufactures, and they do not require so many coincidently developed and converging lines of raw material. Thus, one of the first trades naturally developed would be that in lumber, for which there is a good market in the commercial territory tributary to the Pacific Coast. Following lumber will come in time (not far distant) wood-pulp newspaper and indurated-paper ware, wherein lie the possibilities of a great manufacturing industry. One would naturally expect the manufacture of lead in its various forms, refined copper, and pig iron to become profitable industries at an early stage. But there is no market for these products in the territory open to the Pacific Coast. To the manufacturer they are raw materials of the

crudest kind. Consequently their manufacture in the west is simply governed by the consideration whether the comparative cost of eliminating waste material is greater than the cost of transporting that waste material from west to east. Manufactures based on such a condition do not raise a country out of the category of exporting raw material. Silver, as has already been pointed out, is in a different position. Copper and lead in the form of copper matte and lead in the form of lead bullion pay to ship east, but pig iron (much less iron ore) does not. Therefore the iron resources of this territory must lie dormant until iron can be turned into steel rails and more complex manufactures for which, under the heads of machinery and notions, North America finds a good and growing market in the Orient.

The commercial territory available to the Pacific Coast is of vast extent, wide as the periphery of the Pacific Ocean. It contains population, resources, and possibilities of fruitful commercial intercourse greatly in excess of those represented by European and Atlantic trade. The sum and substance of the argument is this, that if the Pacific Coast, centralised in the Pacific Northwest, is by position, internal resources, and the character of its people, fitted to become the industrial and commercial centre of this Empire, then an industrial development, an accumulation of wealth, a phase of culture, a breadth and intensity of all the activities of human life, which will be the final consummation of the great wave of migratory impulse which has peopled the North American continent, may be expected to be built up upon these shores.

There are certain peculiarities about the character of this tributary territory, however, which make the conditions of development entirely different from those which have contributed to the manufacturing supremacy of the Atlantic seaboard. The manufacturing communities of the east found themselves the masters of a vast inland empire, which was gradually filled up by people of their own race, or assimilated to it, speaking the same language or learning it shortly, inspired by the same ideals, and the victims of the same prejudices. The North American Indian was easily displaced, but the Mongol and the Spanish-American cannot be displaced. Commerce must therefore be developed along different lines. The countries commercially available to the Pacific Coast may be most readily divided into three classes:

1. Countries barren of population, but doubtless possessing extractable wealth. Such are Alaska, the northern portion of British

Columbia and of the Canadian Northwest Territories, and the northern portion of Siberia.

2. Countries which have belonged to the former class but are becoming civilised and populated under an impulse of development similar to that in North America—Australia and New Zealand.

3. Countries possessing considerable, in some cases ample, population, with customs, desires and idiosyncracies peculiarly their own. Of such are Mexico, Peru, Chile, Manchuria, China, Japan, the Philippines, the Dutch Indies, French China, Burmah, and British India, of which Burmah may now be considered part.

With all these countries important and profitable trade relations are being and may be established. But peculiar conditions are attached to every one of them, even apart from the general groups into which I have divided them.

Trade with countries largely barren of population, or, though populated, possessing resources of value to Europeans and Americans of which their people can neither appreciate nor extract the value, will await the same quickening impulse of energy and adventure which opened up and made profitable the middle and western States. This impulse may be strangled by the governments which control such countries. It is one thing to remove the Sioux or the Apache from the path of progress. It is entirely a different thing to uproot the prejudices of the Czar, or to bring a large part of his empire under a commercial dominion which he might view with suspicion and distrust..

As to the second class of country, trade must consist of an exchange of products which North America produces in larger quantities than required at home, for products which North America needs but cannot produce in sufficient quantities or with equal facility. This is trade upon an equal basis, and does not imply any dependence of the one country upon the other.

As regards the last class, trade depends first on the application of energy to make productive resources on which the people of such countries set no value, and second, upon the education of the people already productive, and therefore possessed of consuming power, to require American products as necessary to their comfort and well-being. Of the goods imported into such countries North America supplies a very small proportion. What it does supply is largely made up of the following and similar manufactures: Agricultural implements, cotton goods, electrical supplies and apparatus for scientific purposes, and manufactures of iron and steel, particularly in their

more intricate and complex forms. The trade is limited by some very simple but all-important considerations. One of these is the want of proper shipping facilities, another is the want of a commercial depot in the Orient, another the want of foreign banking facilities, and another the want of foreign commercial initiative on the part of manufacturers. Lines of shipping between Pacific-Coast ports and the Orient are the first essential to the control of Oriental trade. A commercial depot has already been provided in Manila. It must not be forgotten that quotations in American dollars, American methods of advertising, and American methods of collection, are completely incomprehensible to the Oriental mind. There must be some commercial interpreter. Great Britain has provided for that in Hong Kong. North America must do the same in Manila. Financial and banking methods are entirely different where they exist at all, and this must be provided for. The great Anglo-Oriental trading firms have always been bankers as well as traders. Foreign commercial initiative has not been characteristic of American manufacturers because they have had no need for it. Once the stimulus of a profitable export trade is felt, they may be relied on to develop it. American manufacturers have always had a large tributary territory to exploit, which economically speaking, is foreign territory, but in other respects is not. This territory has similar laws, language, religions, courts, and banks. But after all, what difference in nature exists between the trade of Massachusetts with Montana and that of Massachusetts with Manchuria? In the one case as much as the other, it is the commerce of a country producing raw materials with one exporting manufactured products.

A country may export raw materials and import manufactures; or it may export manufactures and import manufactures; or it may export manufactures and import raw materials, which it manufactures, partly for home consumption, and partly for re-export in exchange of different materials of other kinds which it is able to utilise. This is trade and commerce in their widest conception. It is the kind of trade which is realised in the commercial history of Great Britain, and it is towards this kind of trade that the redundant energy and resource of North America are reaching out. Now, the greatest part of the markets for export and import foreign trade which are open or valuable to North America must be reached through the ports on the Pacific. It is all very well to talk of the possibility of supplying steel and coal to Great Britain. But to take pride in supplying steel and coal and raw cotton to Great Britain, from which Great Britain forges

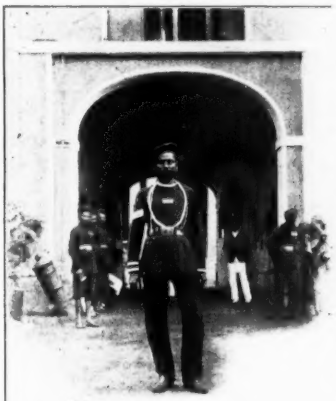
the machinery, generates the power, and produces the cotton goods which supply the markets of the Orient, seems one of two things—either a confession of inferiority, or a total misconception of the commercial situation as it confronts North America. Surely North America's trade opportunities lie where east and west are merged, where there is a market for manufactures, and whence may be drawn commodities differing in utility as one hemisphere differs from another.

In what way, however, does all this particularly affect the future of the Pacific Coast? In this way. The mere passage of commodities through a point does not of itself build up wealth or population at that point, but the fact of being on the line of commerce, and that closer to the market, is what gives a territory the opportunity to establish itself as a manufacturing and commercial country, provided it possesses the necessary resources and its people display the necessary energy. I have tried to show that the Pacific Coast possesses such resources in a pre-eminent degree, but that their development is yet postponed awhile by a number of present disabilities. These, however, are likely to be removed at least as rapidly as the foreign market is opened to its full capacity. The North American continent does not as yet fully recognise its destiny as arbiter of the future commercial life, to which the myriads of population, and countless agencies of production lying dormant in the Orient must awaken. But the day will come when the ports on the Pacific Coast are not only engaged in a great trade in the export of all classes of manufactures, but form a reservoir into which the untold wealth of Oriental nations is poured, there to be manufactured and transferred and adapted to the needs of a great and rich population extending from the Pacific to the Atlantic shore, to the refinement of whose mode of living the world is laid under tribute. Then, indeed, will great cities, "rich, crowded, laughing with the spoil of continents" be built up upon the North American shores of the Pacific Ocean, cities resounding to the hum of commerce, of manufactures, and of ship-building, and forming the ganglia of the commercial nerve-system of the world. Here, indeed, will the impulse of western civilisation be realised in its most glorious, perhaps its final, consummation. Here, in this Imperial situation, holding in one hand the keys of all Europe and America, and with the other embracing the commercial destinies of all Asia and Oceanica, western civilisation, in its peculiar industrial features, will attain a magnitude and a character of domination superior to every phase of it that has gone before, as each of these has been superior to precedent variations.

EQUIPMENT AND METHODS OF THE INDIAN DOCKYARDS.

By A. C. Bowden.

It has been said that one of the largest factors of Anglo-Saxon success in colonising is the racial gift of adaptiveness—the ability to produce effective results with a wide range of mechanical and human instruments. Mr. Bowden's paper has the particular interest of showing a striking instance of the display of this faculty.—THE EDITORS.



Bombay dockyard gate.

MUCH has been made public concerning the ship-building yards of Europe and America, both government and mercantile, but little has been said of late of the expeditious output of work from the two dockyards of the Indian Government—so little that no doubt few of the readers of THE ENGINEERING MAGAZINE, except those who have visited the land of palms and plague, can imagine how advanced these government establishments are or how much of interest they display in their adaptation to peculiar conditions of labour and environment. In this article I shall speak principally of Bombay, leaving Calcutta dockyard for future reference.

The Bombay dockyard, as well as that of Calcutta, is officered from the director of the Royal Indian Marine downward by home-trained admiralty officials, and here lies the root of success; for a record of the output of work clearly shews that officers of limited ability could not venture to cope with the calls made at these dockyards, Bombay in particular. Here may be seen at one time, and have been seen during the past year, equipments for hospital ships, transports for cavalry and infantry, and the usual routine of ship-building and engineering in course of construction. The P. & O. steamship Carthage left Bombay on August 9, 1900, a specimen of ability, and was

H. M S. POMONA LEAVING THE WET BASIN.

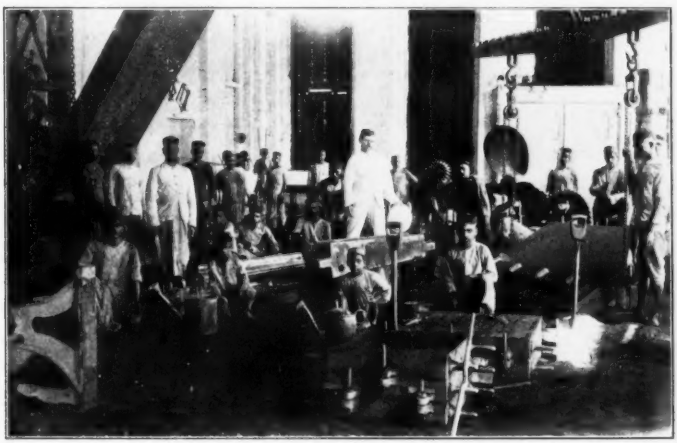
pronounced the finest floating hospital there has ever been. When I speak of the ship-building at this yard I do not mean of battle-ships, but of the lighter and more commercial line of construction—that of launches, tugs, and shallow-draught steamers for treacherous rivers. This present year will see the completion of one of the finest shallow-draught paddle-steamers built for India or elsewhere, for in this vessel the designing naval architect of this yard has embodied all the requirements asked for by the Public Works Department, which is saying a great deal, providing as it does accommodation for ten officers independent of the crew and servants. In this inspection steamer every up-to-date comfort is provided; the saloon is fitted as conveniently as possible, the cabins are furnished with spring chain sleeping berths, sofa seats, and folding lavatories; each cabin, closet, and galley is provided with electric light, and electric lanterns are fixed in the crew's quarters. The dimensions of this steamer are: Length over all, 234 feet 6 inches; breadth (moulded), 23 feet 6 inches; depth (moulded), 5 feet 6 inches; draught, 2 feet 6 inches. To accompany this inspection steamer when on river inspection an observation steam

launch 70 feet in length is provided, and this vessel also is fitted with equal care and comfort.

Bombay dockyard contains a boiler shop fitted with up-to-date hammers, rivetters, and furnaces, and from this shop some of the largest land and marine boilers have been turned out. The foundry, too, can compare favourably with any in India and is capable of castings up to 15 tons' weight. Steel castings can be made here, and in the near future great developments are expected in this direction. As will be seen from the photograph, all the workmen work barefooted.

The factory has done wonders in the building of factory engines, and engines for submarine launches and tugs up to 500 indicated horse power. The engines shewn on page 1005 were built entirely by native labour to the designs of the European engineer officials, the Europeans shewn in the view being engineer apprentices. A horizontal compound surface-condensing engine of 30 nominal horse power has been built during the past year and is now erected at Port Blair, the convict settlement of the Andaman Islands, and is working the factory there.

The electric shop at Bombay is ever modern, although in existence over ten years, the engine receiving steam from a large cylindrical boiler fired by liquid fuel. The whole of the dockyard is lighted by electric arc lamps, and the drilling and boring about the yard done by electrically driven motors. Some idea of the work done here can be gained by the estimates for work during the financial year 1899-1900 (April to March), exclusive of the great stress placed on the officials



NATIVE WORKMEN IN THE DOCKYARD FOUNDRY.

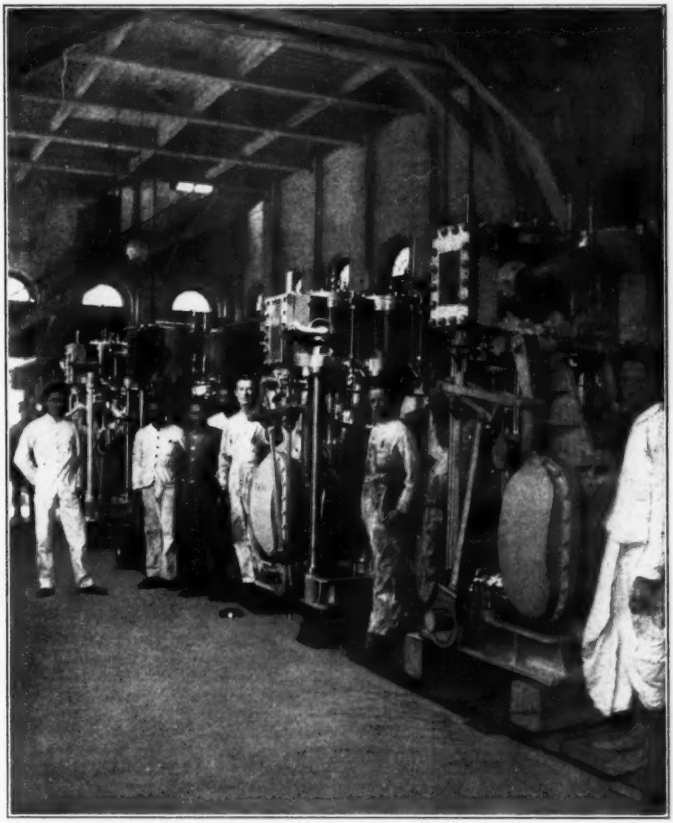
TORPEDO-BOAT WET BASIN.

by the South African expedition, which commenced early in September, 1899. Through the energies of the officials of Bombay, eighteen transports with infantry and cavalry were despatched in eighteen days, and it is recorded went far to save the Empire. It is to be hoped, when the honours are shared, these officers may be recognised. Since September, 1899, fifty-two vessels have been fitted up as transports at Bombay alone, independent of the six trips made by Indian Marine vessels. The estimates for the year amounted to Rs899,884 or, in English money, £60,000.

The mechanical organisation of the yard holds the secret of the successes obtained, and further proves the words of that American authority, Alleyne Ireland, who in his study of tropical colonisation, tells us that the Indian Government's system of organisation is most perfect, and the solution of British rule in India. At Bombay dockyard, the head of each trade (all under the guidance of a naval constructor), is a European officer, who gives his orders to his native chargeman (or "mistri" in Hindustani), and he in turn filters the work out to his less fortunate workmates; but in a country like India, with a populace full of caste prejudices, one is astonished to find men of all castes and creeds working amicably at the same trade side-by-side within the works, whilst outside they are as opposite in religion

THE HARBOUR, FROM BOMBAY DOCKYARD.

and ways as east and west and ready to riot one with the other at the least provocation. It certainly reflects great credit on the old school of the East India Company and Indian Navy, and the officers who followed at the abolition of these companies in 1863, when the Royal In-

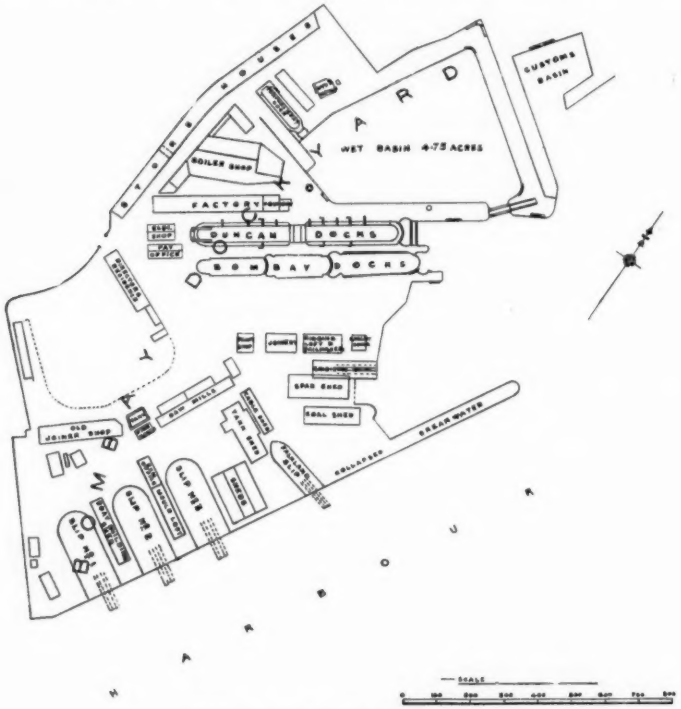


CORNER OF THE ERECTING SHOP, SHOWING GROUP OF LAUNCH ENGINES BUILT BY NATIVE INDIAN LABOUR.

dian Marine was established; for they left a good sound foundation of organisation for the younger school to work upon.

The illustrations on pages 1007 and 1008, aided by the plan of the dockyard, shew clearly the docking accommodation available; in the foreground of No. 1 two out of three of the old Bombay docks can be

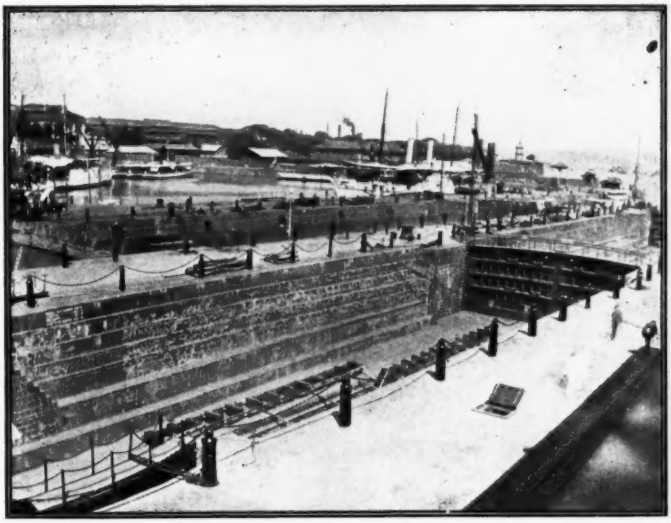
seen, also the open caisson door of the other, which is a covered dock, seen in No. 2. The lengths of the three docks in one line are: Lower, 256 feet; middle, 183 feet; and upper, 200 feet, with a breadth of 51 feet 9 inches. The next couple of docks are the Duncan docks, which have a combined length (with caisson removed), of 641 feet, the upper dock being 302 feet long and the lower 316 feet, with a breadth at the



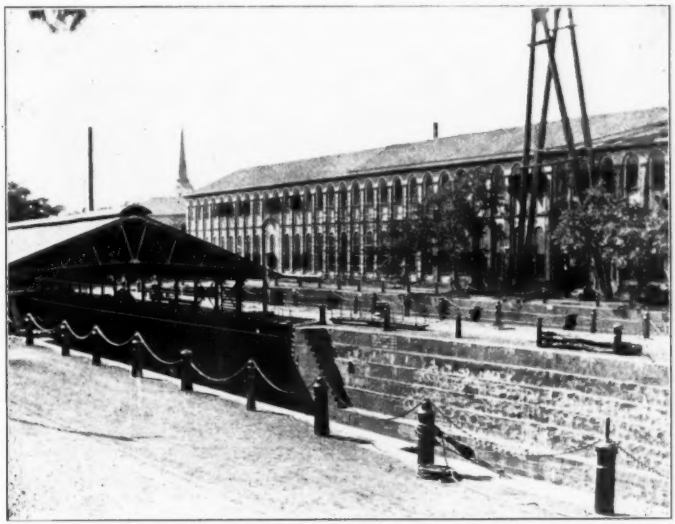
GENERAL PLAN OF BOMBAY DOCKYARD.

entrance of 60 feet. The photograph produced is a fortunate one, as on the day it was taken the whole of the docks were empty for one tide only, the first time this has happened since June, 1897. Beyond these docks is the wet basin with several Royal Navy vessels under slight repair, the vessel in the foreground being H. M. S. Sphinx, employed generally on special service in the Persian Gulf.

The wet basin has an acreage of four and three quarter acres, out of which a small torpedo-boat dry-dock is led, and also a covered

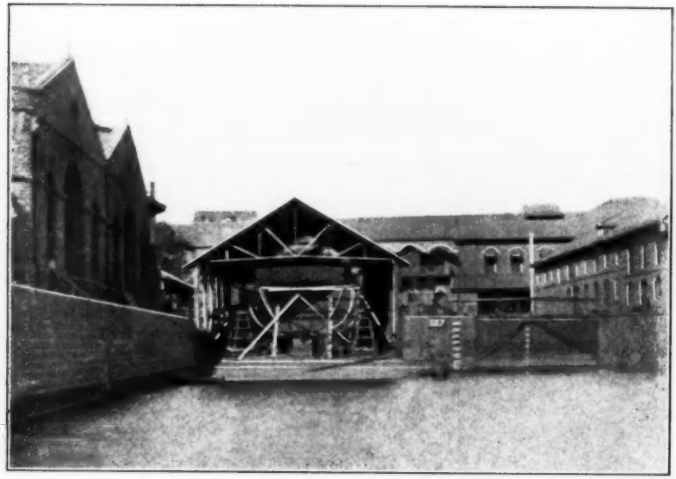


No. 1. Two of the three old Bombay docks—256 and 183 by 51 feet.



No. 2. Covered dock—the uppermost of the three referred to above.

DOCKING ACCOMMODATIONS AT THE BOMBAY YARDS.

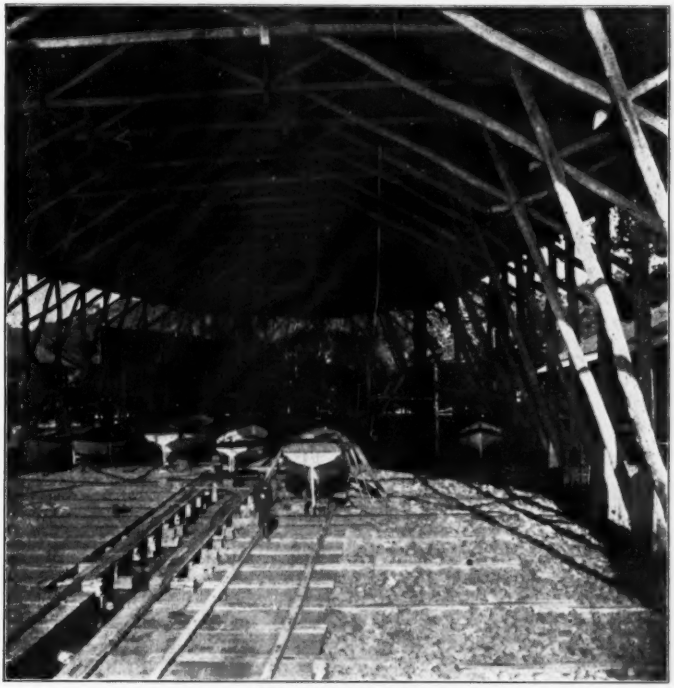


BUILDING SLIP AND ENTRANCE TO TORPEDO-BOAT DRY-DOCK.

THE SAW-MILL.

building slip; the engraving on page 1008 shews a steel barge in course of construction on this slip, and the caisson gate at the entrance of the torpedo dry-dock, the buildings in the background and side being storehouses for Indian Marine and Royal Naval stores.

The photograph on this page shews No. 2 building slip with two



NO. 2 BUILDING SLIP.

submarine mining launches almost completed; from this slip and from No. 1 several vessels of large dimensions have been built and launched.

The yard possesses altogether six dry-docks and a wet basin, one dry-dock with its caisson removed being 640 feet long by 60 feet wide. The dock gates, capstans, and cranes are worked by hydraulic power, and are the production of the noted firm of Sir W. Armstrong & Co., Newcastle-on-Tyne. There are also three covered-in building slips where vessels of large dimensions can be erected and launched.

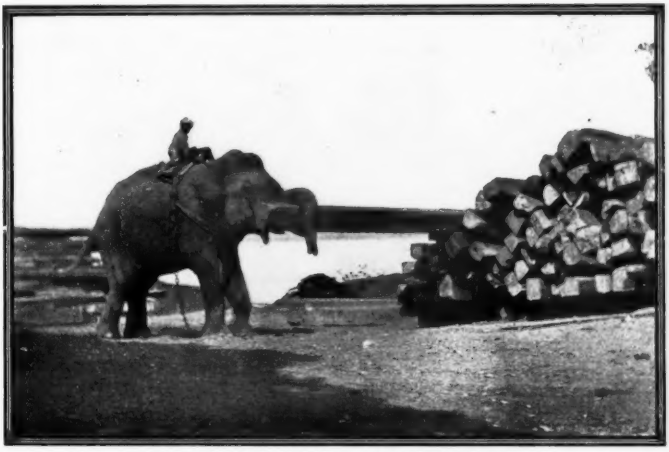
The equipment of the yard both in machinery and appliances is far more up-to-date than a stranger would imagine, for in the new join-

LOADING HORSES ON A TRANSPORT AT BOMBAY DOCKYARD.

ers' shop can be seen general joiners, boring machines, planers, etc., and when completed this branch will be a credit to this side of India. The saw mill is far too small for the calls made upon it at times, but the old vertical saw with its ten blades has been on the move almost continually for the last fourteen months and proved itself worthy of existence.

The cranes about the yard are many and varied, the heaviest being a tripod sheer capable of lifting 35 tons; this towers over the middle of the upper Duncan dock. There are two 25-ton cranes near the wet basin, around which several light whip cranes run on rails for lighter weights; the No. 2 view of the docks on page 1007 shews clearly the sheer legs, the building in the background being the factory and foundry, under one roof.

Bombay, with its yacht club, make a special demand on the dockyard, for a class of racing yacht—"Tomtit class"—was designed and built at this yard; so that vessels of every order, from the flagship of

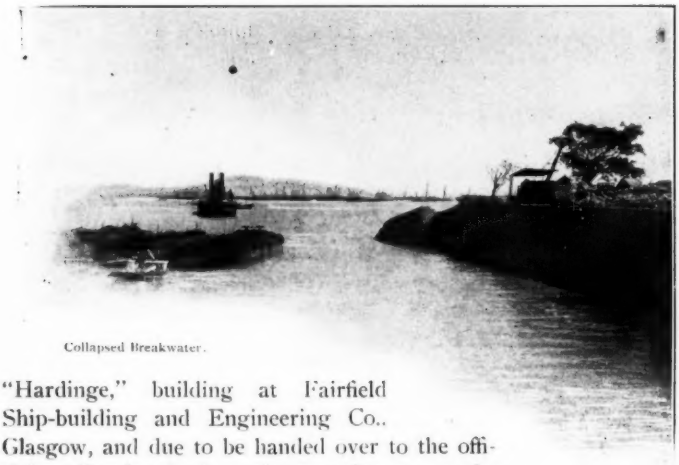


ELEPHANT STACKING GOVERNMENT TIMBER.

the East India station to the racing yacht, look to Bombay for outfit and refit. The storehouses here are many and varied, being divided into sections arranged for the reception and proper care of Admiralty and Indian Marine stores.

The troop-ships of the Indian Marine have proved a valuable adjunct to the Royal Navy, and it is to be hoped that the new transport

THE ROYAL BOMBAY YACHT CLUB.



Collapsed Breakwater.

"Hardinge," building at Fairfield Ship-building and Engineering Co., Glasgow, and due to be handed over to the officials at Bombay in the early part of 1901, may be but one, and a precedent of an Indian trooping service, which would prove itself an efficient and valuable branch of the Admiralty, as it has, in a small way, during the present year.

It may be said in conclusion, that although much has been written in this article of the up-to-date state of Bombay dockyard, yet in the near future an idea will be carried into effect that will make Bombay one of the finest embarking stations in the world; for by the reconstruction of the collapsed breakwater, the construction of another, and the reclamation of some foreshore, Bombay will be enabled to transport regiments of cavalry or infantry at any tide, the railway running down the new breakwater from a branch of the Great Indian Peninsular Railway, so that the troops will be landed from up-country close to the transports ready for departure.

ECONOMY IN FUEL COMBUSTION AND STEAM GENERATION.

By William Wallace Christie.

Progress in steam engineering in the future must be, as it has been in the past, in the line of bettered economy in power generation. The twentieth century may reveal some new and vastly more efficient cycle of transformations than we now know; but for a long time the furnace, the boiler, and the engine will be the three tools on which study must be centered. Mr. Christie deals lucidly with the first of these.—THE EDITORS.

THIS twentieth century, upon which we have just entered, will be noted, perhaps before other things, for the great economies which will be suggested, acted upon, and pushed to their maximum in connection with all of the many trades, processes, mechanical operations, shop management, and power generation and transmission. Heretofore, for example, coal has been furnished to the consumer by the ton, thrown into the furnace, and, as a friend expressed it, "all we know is that the steam is made and the work is done." The world is beginning to realize that there are (as there always have been) about 14,000 British Thermal Units in one pound of good coal; therefore, since coal is bought for the heat it gives in return, they look for results.

If a steam engine develops an indicated horse power on 100 pounds of water, there are but few who do not recognize in that figure a great waste. How many steam users, seeing a boiler horse power developed with 7 pounds of coal per hour, know that 3½ to 4 pounds would be nearer the economy attainable if we used efficient means for getting all of the heat possible from the coal to the water in the boiler? The boiler which gives the greatest economy, and consequently the highest efficiency, is the one whose furnace proportions, construction, setting, and care are all given the most thorough study. Many steam plants in operation, for lack of this forethought, are miserable failures as economical steam producers. Each of the items requires the fullest consideration. This article will be devoted to the setting proper.

Ashes, which accumulate under every boiler, need but little room; space sufficient for the ordinary accumulation of refuse should, however, be left, so that the draft will not be interfered with nor the grate

suffer injury. The distance from boiler-room floor level to the top of the grate bars varies in different types of settings; from 24 to 30 inches is current practice in stationary boilers. In large plants, however, where the boilers are worked hard and continuously night and day, the ash pits are provided with hopper-shaped bottoms or floors, terminating in tubes having closed ends, so that the ashes may be more easily removed by conveyors or by cars running underneath the tubes; in plants of lesser magnitude the wheelbarrow and the man behind it are employed.

Directly over the ash pit is placed the grate, which has an important part to perform in distributing the air through the fire, as well as in supporting the fuel during the process of combustion; 12 pounds of air are needed for the complete combustion of one pound of coal, theoretically; with ordinary natural draft, if poor, 100 per cent. additional air must be supplied, or 24 pounds of air per pound of coal; with mechanical draft and closed ash pits, only 50 per cent. additional air is required to give good results—18 pounds of air per pound of coal.

The sizes of coal commonly burned in the United States are classified thus:

SIZING TESTS—ROUND HOLES AND PUNCHED PLATES.

Chestnut	through 1 1/2	inches,	over	7/8	inch.
Pea	" 7/8	"	"	9/16	"
Buckwheat	" 9/16	"	"	3/8	"
Rice	" 3/8	"	"	3/16	"
Barley	" 3/16	"	"	3/32	"
Culm	" 3/32	"			

The size of the coal determines the air space which it will be desirable to have in the bars, which has been standardized in this way: *

1/4	inch opening,	1/8	inch bar	for	screenings.	
3/8	" "	3/8	" "	"	buckwheat	coal.
1/2	" "	1/2	" "	"	nut or pea	"
5/8	" "	1/2	" "	"	stove	"
3/4	" "	1/2	" "	"	egg	"
7/8	" "	1/2	" "	"	broken	"
1	" "	1/2	" "	"	lump	"
5/8 to 3/4	" "	1/2	" "	"	bituminous	"

The particular style or pattern of bar used may be selected according to one's liking. Some engineers have a preference for the rocking over the stationary grate bars, others for the herring-bone tupper bar over the common single or double slab bar. Shaking and dumping grates, if operated in two or more sections, allow the fire to be cleaned without requiring the fire doors to be opened as great a

* For more complete table see Chimney Design and Theory, by W. W. Christie.

length of time as is imperatively necessary in hand cleaning. I have found a saving of about 3 per cent. in dumping grates over stationary tupper bars, used under the same horizontal return-tubular boiler; the economy was due principally to the saving in time required for cleaning the fire and consequent prevention of the inrush of a large volume of cold air. Grate bars set at a slight inclination toward the back of the furnace give better results than those which are perfectly level; a drop of 3 inches is recommended by the Hartford Steam-Boiler Insurance and Inspection Company. This company also advise a cement-concrete ash pit 6 inches deep, with sloping sides below boiler-room floor level, allowing the ashes to be quenched with water and to be easily drawn out on the floor.

Mr. G. H. Barrus, reporting on tests of a boiler under which the fuel was fired in various ways, records that with uneven fires an equivalent evaporation of 9.149 pounds of water from and at 212° F. per pound of combustible was obtained, as against 9.55 pounds of water with even firing—showing a substantial benefit or gain due to careful firing, and incidentally the value of "brains" in the boiler room. The various stoker methods of automatic fuel-feeding or firing and their special grates will not be discussed at the present time.

Open fire, ash-pit, and boiler doors result in a positive injury to any and all boiler settings, and prevent at the same time the attainment of the greatest efficiency. The opening of a door over the fire for a moment reduces the temperature of the escaping gases very considerably, a drop of 100° F. having been observed by me.

The distance between the grate bars and the metal which composes the boiler shell containing the water to be evaporated is a most important dimension, meriting a separate consideration for each boiler setting. It depends not only on the kind of coal to be burned, but likewise on the rate and intensity of the combustion. Many engineers use 30 inches as the proper dimension for a 100-horse-power boiler, though as great a distance as 4½ feet has been used. In the Manning type of boiler the height of the crown above the top of grate is about 3 feet for a 100-horse-power boiler; within the last three years some special boilers of this general type have been built having the fire box about twice as deep; the results under test have not been made public.

The rate of combustion also plays a most important part in the efficiency of a boiler. It may be low on a large grate area, high on a small grate area, or medium on areas intermediate between these extremes. Prof. Goss has experimented with a practically uniform quantity of coal burned in a given time, in a locomotive boiler, and

by varying the grate area he secured rates of combustion widely different, obtaining these results in evaporative efficiency:

	1	2	3	4
Coal per sq. foot of grate per hour, lb....	61.40	83.50	124.20	240.80
Equivalent evaporation from and at 212°, lb.....	8.26	7.87	7.52	6.67
Equivalent evaporation per square foot of grate, lb.....	15.00	19.00	26.00	47.00
Smoke box temperature.....	647°F.	629	610	500

These figures show that even with forced draft, beyond a certain rate of combustion, the temperature of the escaping gases decreases, and the highest efficiency is obtained with the highest temperature in the flue. Anthracite coal requires a larger grate area and air space in the bars than bituminous coal, so that the amount of coal burned in an hour, and its character, become of secondary consideration only to the area and disposition of the heating surface. Many boilers are failures as economical steam generators because of the lack of consideration given one or more of these details.

As the fuel gets poorer in quality and comes to the boiler room in smaller particles, the draft necessary to burn it is greater; consequently to avoid the expense and outlay of money for chimneys tall enough to burn slack, culm, or other inferior grades of fuel, mechanical methods are often employed to produce the desired draft.

We now come to the heating surface, whose function is to afford the least resistance to the passage of the heat from the gases to the water, and at the same time to contain and hold that water in the hottest parts of the fire. The ratio of heating to grate surface in stationary boilers is about 35 to 40, but in my opinion the heating surface should always be proportioned with regard to the pounds of coal to be burned per hour on the grate, and consequently with regard to the boiler horse power to be developed. A fair average of American practice in stationary boilers is one square foot of heating surface* for each 0.3 pounds of coal burned per hour per square foot of grate. With one of the types of vertical boilers tested under varying rates of combustion, the highest economy was secured when the area of the heating surface divided by the area of grate surface was 34.2 and when 0.28 pounds of coal per hour were burned on the grate for each square foot of heating surface.

C. Wye Williams says "a rapid combustion is more economic of time, and slow combustion of fuel," which statement, though made

* See table, p. 25—Chimney Design and Theory, by the author of this article.

many years ago, is full of force to-day. The best rate of combustion for most economical evaporation of water, as far as fuel is concerned, is when about 13 pounds of anthracite coal are burned per square foot of grate per hour,* while for bituminous coal a slightly heavier fire is needed, and the above figure should also be greater.

For the relative economy of anthracite and bituminous coal under locomotive boilers we have these results from two prominent railroads:

	1.	2.
Bituminous coal	68.3	54
Anthracite "	65.3	50
Anthracite waste	69.4	—
Bituminous "	64.3	—

Tests made by me upon two Manning vertical boilers, with two coals, under the same conditions, gave these results:

	Buckwheat coal test.	Bituminous coal test.
Temperature of escaping gases	372°F.	427.16°F.
Rate of combustion	18.15	17.80
Nominal rating, horse-power	500	500
Boiler horse-power developed	431.65	493.86
Water evaporation per square foot of heating surface per hour	0.198	0.227
Equivalent water evaporation from and at 212° per lb. of combustible	9.80	9.81

Here, too, we have greater efficiency, with increased flue temperature. Other tests, with different boiler settings, could probably be suggested to show the superiority of anthracite coal.

The area or cross-section between the top of the bridge wall and the boiler shell, in the type of steam generator which has a bridge wall, is given by one authority as 1¾ square inches per pound of coal burned per hour on the grate. When tabulating the contents of the combustion chamber of horizontal return-tubular and Manning types of boilers, I found that, with one Manning boiler tested at five rates of combustion, the greatest efficiency was reached when one boiler horse power was developed with 0.89 of a cubic foot of air space in the combustion chamber. For the horizontal return-tubular boiler, one boiler horse power was developed very efficiently with 1.03† to 2.08 cubic feet of air space in the combustion chamber.

A horizontal return-tubular boiler 68 inches in diameter by 18 feet long, having 87 3-inch tubes, burning anthracite coal on a grate area of 34.5 square feet, developed one boiler horse power with 1.03† cubic feet of air-space in the combustion chamber and did so efficiently;

* Paper DCCXVII.—Trans. A. S. M. E., Vol. XVIII.
Paper DCCLXV.—Trans. A. S. M. E., Vol. XIX.

† These tests were made at different times—not by the same person.

when the same boiler had its draught forced 60 per cent. it showed a decided loss in evaporative economy.

Mr. John Bourne* gave the relations of the parts of a boiler as follows in parts per boiler horse power:

	Cubic feet between.	Cubic feet, average.
Capacity of furnace chamber above grate bar.....	0.78 and 1.7	1.17
Water space in the boiler.....	3.74 " 7.3	5.
Steam " " "	1.4 " 5.7	3.2

Thus far we have had in mind only the ordinary self-contained furnace, underneath the boiler, in which all the radiant heat is immediately about the shell; a type of furnace is, however, being brought prominently into notice now which is separate from, and is placed in front of, the boiler setting proper; it has an arched top, lined inside with fire-brick, so that the fire produces in it almost a white heat, and the gases, which are partly consumed in the furnace, pass out very hot about the boiler, where the combustion is completed, the air being mixed with the gases before they are cooled down, as in ordinary furnaces. By the use of two or more fire doors and alternate firing quite a uniform heat can be maintained. The combustion chambers virtually become gas producers; this type of furnace is one especially adapted for the burning of bituminous and semi-bituminous coals, and gives a very high evaporative efficiency. In addition to these we have the down-draft and other patent furnaces and also mechanical stokers.

The marine boiler is frequently used on land, and when set up out of doors, with no covering or lagging, not even a shed for its protection, becomes more of a condenser than boiler in rainy weather; but with a good setting and the proper insulation of its exposed outer shell, high evaporative results may be obtained. A gun-boat type of boiler with a corrugated-steel fire box tested by Dean and Main with varying rates of combustion gave for temperature of escaping gases the following results:

Rate of combustion, lb., per sq. ft. of grate per hour.	Temp. escaping gases, degrees F.
20.9	482
21.3	472
28.1	516†
28.5	496
29.3	511
31.6	526

The above is an example of a good installation of the marine type of boiler.

* "Artisan Club" Treatise on the Steam Engine.

† This test gave the highest evaporative efficiency.

The locomotive boiler is another favorite for land use in certain parts of the United States. Some years ago the Calumet and Hecla Mining Company had a large number of locomotive boilers built for stationary use, from special designs, which are said to have given good results. The tubes in this type, as used "on the road," are, however, of small diameter; they quickly become clogged with ashes and soot unless a very strong draft is furnished when the boiler is used for stationary work.

From exhaustive tests it has been proven that the resistance to the passage of heat from gases to water is usually 300 times as great as the resistance of a copper plate ⅜ of an inch thick. The efficiency of the boiler therefore does not depend upon the thickness of the metal in the shell, but rather upon good circulation—upon carrying steam away from the hottest parts of the shell and allowing water to take its place. Extra length of boiler tubes in locomotives is of no practical value so far as concerns increase of steam-generating or heating surface, as we see from some French experiments conducted with boilers having tubes of varying length. The gases, as they passed through, suffered very little diminution of temperature or loss of heat at the far end after a certain length of tube had been exceeded.

The maximum length of locomotive-boiler tubes in the United States is 16 feet to 16 feet 7¾ inches for a tube 2 inches in diameter; elsewhere lengths of 17 feet 5 inches to 18 feet 1 inch are used with success, and even tubes having a length of 20 feet are considered practicable. The effect of a greater or less number of tubes in a boiler is shown by tests made with a Wigan boiler; the tubes all being open, a rate of combustion of 25 pounds of coal per square foot of grate per hour gave 12.4 pounds of water evaporated from and at 212° F. per pound of coal. Plugging alternate diagonal rows of tubes, thus reducing the heating surface by 206 square feet, resulted in an equivalent evaporation of 12.2 pounds at a rate of combustion of 24 pounds of coal per square foot of grate. In the first case light smoke lasted 2.8 minutes; in the second, 8 minutes. From these tests, as well as from others, it may be seen that with twice the velocity of the gases in the tubes we have twice the evaporation from each tube, without any material loss in the efficiency of the boiler. Does it make a great difference then, as some would have us believe, whether we have seventy 4-inch or forty-five 5-inch tubes in a 72-inch diameter horizontal-tubular boiler shell, or even a less number of either, provided we supply the proper draft?

There are still many men, who, when setting a horizontal return-

tubular, build a tight brick arch over the top of the setting, thus passing the gases over the top of the boiler entering the chimney flue from the rear. This manner of construction cannot be too strongly condemned, for it not only prevents ready inspection of the boiler, but also is not productive of any greater evaporative efficiency; in certain cases it may prove a positive detriment, for if the gases become too cool to give up any more heat to the boiler they will abstract heat from the steam already made.

The side walls of boiler settings are often built as one solid wall, but if they are built with a 2-inch air-space (front wall excepted) the walls are more substantial than when solid; more masonry is required than for a single wall.

Particular attention should be paid to the laying up of double walls so that they are not tied together in the masonry, as the fire side of the wall expands considerably more than the outer portion and rigid interlocked connections cause cracks. The excess of expansion of brick over iron in boiler settings is about 2½ inches for the fire side and 1 inch for the cool side, in 15 feet, and cannot be ignored by designers. Not allowing for this difference in expansion is the cause of a great many cracks in boiler-setting masonry.

After the gases leave the boiler—in which they should circulate about the heating surface in such a manner as to give up all but so small a margin of their heat as will still leave them at a temperature exceeding that of the steam—they pass through the gas flue to the chimney or blower. The path of the escaping gases to the chimney should be as direct as it is possible to make it. An angular bend of ninety degrees offers twice as much resistance to flow as a curved bend of ninety degrees having a radius of say four times its diameter, if round, or four times its width if rectangular.

Gases in passing from a boiler through a 27-inch diameter flue having a curved bend with a center line of 48-inch radius suffered a loss of 10 per cent. of the draft they had before reaching the bend.

In designing ninety-degree or other angle bends, if we should enlarge the cross-section through the bend 25 per cent. for ninety degrees, and proportionately for other angles, the friction loss would be reduced to a minimum. Gas flues should be protected by some sort of an insulating covering throughout their entire length, for the economy of the boiler will be materially assisted by maintaining the temperature of the escaping gases without a drop, from the time they leave the boiler breeching until they reach the chimney; for the in-

tensity of the draft is a direct function of the absolute temperature of the escaping gases.

The equivalent evaporation of 12 pounds of water per pound of combustible may be taken as a standard of evaporation; with a good grade of coal this should be possible in a good setting with a temperature of the escaping gases of 500° F., or slightly less; if a higher temperature exists, we would, for the ordinary rates of combustion, have a decrease in economy to the extent of about 5 per cent. for each 100° F. elevation of temperature of the escaping gases.

The influence of a particular type of setting upon the efficient working of its boilers is shown by the following tables:

BOILER A.

Rate of combustion, lb...	10.66	11.69	13.32	14.84	17.2	17.63	21.74	28.28
Temperature of escaping gases, F.....	462	478	480	485	421	543	503.8	654

BOILER B.

Rate of combustion, lb.....	10.9	10.9	13.16	13.6	14.7	15.3	23
Temperature of escaping gases, F...	420.5	477	500*	522	495.9	554	531.4

BOILER C.

Rate of combustion, lb...	10.88	13.1	13.87	15.3	17	17.2	18.7	19.7	20	20.8
Temperature of escaping gases, F	608	652	700	716.5	602.8	463.7	697	588	622.8	611.8

With a uniform range of rates of combustion,

Boiler B gives off its gases to the chimney at 420°—531° F.
Boiler A gives off its gases to the chimney at 462°—654° F.
Boiler C gives off its gases to the chimney at 463°—697° F.

which gives a fair idea of the relative value of the settings.

The length of the gas flue, when about 800 feet, without a bend, decreases the draft one-half.

The draft at various parts of a setting, as actually measured in a certain boiler, gave:

At the chimney base, 0.514 inches of water;
At the second pass, 0.445 inches of water;
At the top of first pass, 0.394 inches of water;
At the furnace, 0.242 inches of water;

Showing a well-protected gas flue.

Oval or round gas flues, like round chimney flues, offer much less resistance than do square flues, and the gases when passing from them up the chimney should have a curved path, not an angle, as in the usual method of construction.

We often find that the area of gas flues and their entrance ar-

* Most efficient.

rangement into the chimney are adapted only to present requirements; for example, in a brick chimney designed for four boilers, the flue entrance to the chimney had the proper area for two boilers, while the gas flue area was inadequate for two boilers. With these conditions existing, a second boiler, with its smoke flue, had been added to the original boiler setting, a third added to the second—in each case extending the original flue area.

On the continent it is customary to use brick chimneys having the gas flue built of masonry laid and entering the chimney below the ground level. In the United States the contrary obtains, gas flues of steel being used in the majority of power plants, entering the chimney above the ground level, thus reaching the chimney at a place of greater weakness than when entering below the ground level; frequently two gas flues enter the chimney from opposite sides, which is very undesirable.

The area of the chimney flue should be proportioned in accordance with the capacity desired in it; the height should be sufficient to provide, with a given flue temperature, the necessary intensity of draft to burn a definite amount of coal, though a chimney much too large for present needs, with no immediate prospect of increased boiler plant, is not desirable. It would be better to erect another when the greater need comes, so connecting the flues leading to them that either or both may be employed in emergencies.

In an exceedingly large plant it is not wise to place all of your confidence in one chimney; chimneys in multiple are better.*

After having introduced to the reader some general rules of practice, which, if followed, will result in a commercially perfect boiler setting, the essentials may be summarized as follows:

1. Proportion all of the parts for the work to be done.

2. Use only the best materials and workmanship in construction and setting.

3. Keep the boiler clean, inside and out.

4. Watch the temperature of the escaping gases; do not allow it to rise above an economical point.

Authorities differ on this point, for 273° F. + outdoor temperature, or about 340° F., is given by one authority, 584° F. by another, and 600° F. by still another authority, as that temperature of the gases in the chimney which will produce maximum draft and delivery of gases. The tests quoted in this article show 500° F. or less to be an economical point, so far as the evaporative efficiency of the boiler is concerned.

* Railroad Gazette, Oct. 19, 1900.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

II. GENERAL GEOLOGY OF THE GOLD-FIELDS, AND THE PROCESS OF DRY BLOWING.

HAVING dealt with the history, position, and general features of the Coolgardie and Kalgoorlie gold-fields, with special reference to their topography and to the various agencies that have contributed to produce the results which are to-day visible *on the surface*, I will now pass on to the *internal geological structure* of the central plateau of Western Australia, in order to arrive at some idea of the conditions under which its gold deposits have been formed, and the local peculiarities which characterise and distinguish them from ordinary auriferous lodes and alluvials in other districts.

Treating the subject from the broadest possible point of view, the greater portion of Western Australia seems to consist of crystalline rocks of Archæan age, composed of granites, gneisses, and schists, which cover large areas distinct from one another, running in parallel belts approximately north and south with a slight northwesterly trend. Notwithstanding, however, an outward appearance of similarity, as will be seen later on, when studied in detail the same belt may present locally considerable diversity in geological structure; this no doubt explains the existence of enormously rich gold deposits in certain areas and their poverty or absence in others, although to the superficial observer the surrounding conditions seem much the same.

Mr. H. P. Woodward, F. G. S., F. R. G. S. (late government geologist), considers that there are six of these belts, each possessing distinctive features of its own.*

1. The most westerly belt, which extends along the shores of Western Australia, from the south coast to the Murchison River, which is seen exposed at Northampton, the Irwin River, and between Capes Naturaliste and Leeuwin, consists of clay slates, quartzites, and schists, which are characterised by the frequent occurrence of copper, lead, zinc, iron pyrites, and ferruginous graphite.

*Mining Handbook to the Colony of Western Australia. Perth. By authority.

Mr. Charleton's preceding article appeared in THE ENGINEERING MAGAZINE for February, 1901.

2. The second belt, which lies parallel with the first, forms the bold escarpments of the Darling Range, turning northeast beyond the Murchison River, and 200 miles further north disappears beneath a magnesian-limestone formation. In this belt the rocks are composed of hard crystalline gneiss and schist, penetrated by dykes of diorite, granite, and felstone, and veins of quartz, in which several minerals of commercial importance are found, viz., tin (at Greenbushes), iron, manganese, mica, asbestos, and graphite, of which a deposit was discovered near Bridgetown, in 1896.

3. The third series lies 100 miles east of the west coast, forming what Mr. Woodward calls "the great granite belt," which, so far as is yet known, seems devoid of workable deposits of mineral.

4. The first auriferous belt possesses a width of some 20 miles, and lies east of "the great granite belt," with which it runs parallel, starting at the Phillips River in the south of the colony, and passing through Southern Cross, Mt. Magnet, and Cue; then turning northeast at Nannine, it finally disappears beneath the Palæozoic rocks, where the Henry River joins the Ashburton.

The rocks of this belt are mostly hornblendic, micaceous, and talcose schists.

5. The next belt is nearly the same width as the last, and is very similar to it in character, except for the absence of payable gold.

6. The second auriferous belt, of which the width is yet unknown, extends from the Dundas hills, through Coolgardie, Ullaring, and Lake Carey, following a parallel line with the others, and turning, like them, to the northwest through Nullagine, Pilbarra, and Mallina.

The rocks in this area are very similar in general character to those of the first gold belt, viz., hornblende, mica, and talc schists.

Baron Sloet van Oldruitenborgh* believes that the table-land just described, of which the greater part of Western Australia consists, was elevated in Pre-Cambrian times, and was pierced by numerous overflows of diorite, diabase, etc. (probably of submarine origin), which were the precursors of the uplift to which the Australian continent owes its existence.

He observes further, that "very likely towards the end of the Permo-Carboniferous period, the probable sinking of the continent resulted in an intense compression in an eastward direction of the whole of this mass of rocks, generating an east-northeasterly thrust, extending along the coast of Western Australia for a length of about

* Technical Observations on the Coolgardie Gold Field by Baron van Oldruitenborgh, translated from the French for the *London Mining Journal*.

800 miles, which upheaved a doubly folded chain, running north-northwest, perpendicular to the direction of orogenical pressure."

The roots of this chain, which has since been planed down, are in consequence now exposed at the surface, and consist of the parallel belts of granite and gneiss, etc., of which mention has been made.

Mr. C. S. Göczel,* on the other hand, considers that in Palæozoic times this portion of the continent formed part of a volcanic archipelago, around which the greater part of Western Australia was built, and in early Mesozoic times (when the gradual upheaval of the continent was completed), volcanic action apparently died out in this part of the globe, although it continued to manifest some seismic and hydrothermal activity; the agency to which he ascribes the formation of most of the primary gold deposits, during later Palæozoic times.

With the elevation of the country above the sea, and the cessation of volcanic activity, Mr. Göczel considers a new era commenced, during which great depressions occupied by inland lakes and estuaries were successively filled in with rock material derived from the adjacent highlands.

He remarks, later on, speaking of Coolgardie,† that "The main fissures extend for miles, and contain predominantly eruptive rock-material, whereas ferruginous quartz, with a higher or lower gold yield, is only of secondary occurrence within them." The dykes consist, he says, usually of diorites, diorite-porphyrites, and porphyrites.

Dr. Chas. Chewings, Ph. D., F. G. S.,‡ like Baron van Oldruitenborgh, expresses the view that the Coolgardie goldfield is the remnant of a large mountain chain, almost obliterated by denudation, which marks a line of weakness in the earth's crust, through which the materials forming the chain were poured, whilst vast quantities remained beneath and have been exposed at the present surface through the removal of the upper portions.

He considers the prevailing metamorphic rocks in this area consist of schists and slates, which chemically range from the most acid to the most basic—petrologically, from amphibole§ to quartz-schist—and that they are probably of Pre-Cambrian age.

The absence of fossil remains, superficial deposits covering the

*The Interior Gold Region of Western Australia, Appendix 4, ad interim Report Depart. of Mines for half year ending June 30, 1894.

†Report of the Depart. of Mines for the year 1895.

‡Geological Notes on the Coolgardie Gold Fields, a paper read before the Royal Colonial Inst., March 17, 1896.

§Hornblende.

bed-rocks, the want of accurate geological information about many parts of the colony (much of which remains practically unexplored), and breaks in the continuity of the series, even when the position of certain "formations" can be determined accurately here and there, all tend to render it difficult to settle the relative ages of the rocks of Western Australia, and strew the path of the wary but untiring geologist with difficulties.

Recent Superficial Deposits.—A large portion of the Coolgardie field is covered by recent superficial deposits, which vary in depth from a few inches up to some hundreds of feet (as proved by a section at what is known as Rollo's bore-hole), the flats and slopes west of the township being buried underneath this blanket of alluvium. On the surface, it consists of loose sand and quartz fragments, resulting from the decomposition of the granite, "cement," and quartz reefs, mingled with ferruginous matter derived from the hornblendic rocks and iron-stone gravels referred to later on.

The quartz particles are usually of small but varying sizes, and are more or less rounded by the action of the wind; whilst at greater depth, where they lie on the eroded surface of the granite, they are larger and are usually sub-angular, having apparently been exposed to the action of water in what seem to have been ancient subterranean water-courses.

Quartz of this kind, it is said, rarely if ever shows any free gold. The impure oxide of iron, of which a large part of the alluvium consists, is in a fine state of division on the surface; but lower down large, loose, rounded pebbles of iron-stone are met with in patches, and in many cases show free gold both in the exterior and on freshly broken surfaces. On approaching the granite on which it rests this deposit often becomes so compact as to necessitate the use of explosives to break it, being cemented together by the iron which has been dissolved out and re-deposited. Under a lens the finer samples show the presence of garnets and zircons, occurring in broken and partially worn fragments, together with magnetic iron, commonly known as "black sand."

Iron-stone Gravel Deposits.—The remnants of these deposits are found widely scattered over various parts of Western Australia, overlying the granite, and occur exposed in semi-detached patches in the Coolgardie field, following a north-and-south line on the outskirts of the alluvials, to which they have doubtless contributed much of the iron which imparts to the latter their red colour. At Coolgardie and elsewhere, however, when exposed at surface, this deposit has

been largely removed by denudation except where it lies in hollows in the eroded surface of the bed-rock.

Mr. Blatchford is of opinion that these iron-stone gravels have been most likely derived originally from older beds of ferruginous clay, long since altered *in situ* through concretionary action into iron-stone nodules, that have been changed at surface into the hard iron-stone pebbles which are so frequently met with.

In places these pebbles become re-cemented together into the lumps of impure iron stone which are often found outcropping on high ground, and as judged by a sample analysed in the government laboratory the composition of this iron stone appears to be: Fe_2O_3 35.25 per cent., Fe O 00.51 per cent., equivalent to 25.07 per cent. of metallic iron; assays made of the "gravels" show from 3 to 8 pennyweights of gold per ton.

They lie at Coolgardie at a tolerably uniform level between 1,380 and 1,460 feet above the sea, and Mr. Blatchford thinks that the same may be said to be the case in other parts of the central table-land. Their nodular appearance seems to be due merely to surface weathering, and he regards them as ferruginous clay-stones, resulting either from the deposition of volcanic dust or a detrital deposit derived from more or less basic rock, in either case deposited in water.

Whilst minor deposits of a somewhat similar character are found at lower levels, as at Coates' siding in the southwest portion of the colony and elsewhere, which evidently originated from the surrounding rocks, Mr. Blatchford contends that, in view of their wide distribution and the facts that have been already stated, there seems much likelihood that these singular iron-stone gravels are of marine origin, and he places their age between Jurassic and Miocene or Pliocene—probably the latter, judging from their lithological character. Underneath the iron-stone gravel, between it and the granite, patches of so-called "cement" are sometimes found forming a sub-stratum which attains in places an average thickness of about 3 feet; and although what little of it has been found at Coolgardie itself has not thus far proved payable, very similar cement deposits discovered at the 25 mile and at other places in the surrounding districts have turned out extremely rich.

Just in the same way that California and Victoria owe their early prosperity and rapid industrial development to the discovery of alluvial gold, so Western Australia is indirectly indebted in a great measure for its present thriving condition to the alluvial diggers, who, acting as pioneers of the mining industry,

paved the way for the quartz-miner and capitalist, who invariably follow in their wake. As Mr. T. A. Rickard justly points out, however, the discovery of the rich telluride lodes at Hannan's, and the development of "this immense desert country, dotted over with the unhappy failures which were based on small pockets of 'specimen gold-quartz,' did not happen without a sad expenditure of money and human life."

The peculiar character of the gold "rushes," is, in fact, in no small degree traceable to the nature of the gold occurrence, "since gold is found lying on the very top of the ground, and the first surface mining yields extraordinary profits" to the individual discoverer. Hundreds of ounces have thus been picked up by the first-comers, "specking" for gold, as it is called; the sandy patches of alluvial where discoveries of this kind are generally made being afterwards turned over and treated by the "dry blowers," who have trenched and pitted the surface in all directions in the search for a rich location.

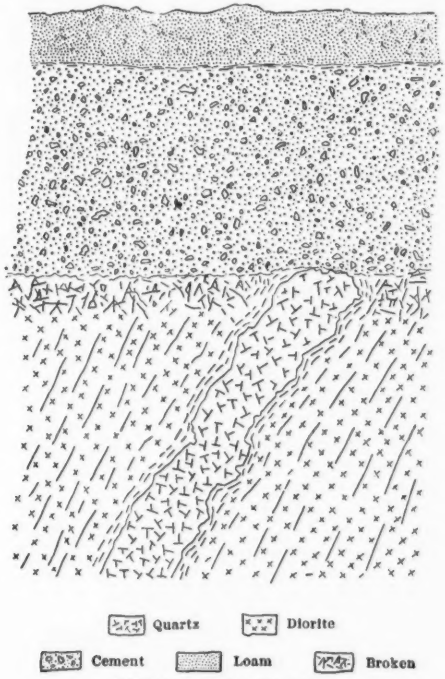
On Sundays and holidays, when regular employment is at a standstill, miners otherwise engaged during the week may be often seen out "specking," employing their leisure in quartering a likely spot, with their hands in their pockets and eyes bent on the ground, like men lost in deep thought; but it is devoted to one subject—the discovery of the lost trail of a nuggety bit of gold.

The fragmentary overburden of detritus of which these "superficial alluvials" consist (termed by the Australian miner "made ground," to distinguish it from the underlying bed rock on which it frequently rests), covers at times accumulations of consolidated auriferous material termed "cement," which, as Mr. Rickard observes,* "are more extensive, and quite apart from their greater economic value are also of superior interest, because of their better-defined geological features."

Alluvial Deposits.—The discovery of alluvial gold at Kalgoorlie was made on Saturday, June 17, 1893, by three prospectors—Patrick Hannan, Dan Shea, and Tom Flannagan—whilst travelling from Coolgardie to the Mt. Yule rush. The following Sunday hundreds of men were flocking to the scene of this find, on camels, bicycles, horses, and on foot, who little suspected the immense wealth that lay buried in the neighbourhood under the arid waste of reddish loam, gritty sand, and gravel containing iron-stone, travertine, and fragments of quartz, with which the surface of the country for miles around was covered.

* The Alluvial Deposits of Western Australia, by T. A. Rickard, A. R. S. M., State Geologist, Colorado. Trans. Am. Inst. of Mining Engrs., 1898.

The theatre of these early operations was below the hill which overlooks the township. Curiously enough, however, this discovery has not up to the present led to the discovery of any reefs of importance in the immediate neighbourhood, although the surrounding area, like many others, was given up to purposeless digging, which gave an impetus, as Mr. Rickard says, to a great deal of reckless company-promoting.



VEIN CAPPED BY ALLUVIUM.
Reproduced by courtesy of T. A. Rickard, Esq.

"However, just as in Colorado the Mt. Pisgah fiasco of 1884 preceded the real development, eight years later, of Cripple Creek, so the vagaries of irresponsible schemers led to the accidental opening up and the eventual recognition of the magnificent series of rich lodes that have now placed Kalgoorlie amongst the few great mining-camps of the globe," and towards the end of 1895 there were no less than 3,000 people congregated at Hannan's. Such veins as were found at the northern end of the field, however, were, as already said, so small, patchy, or poor, as to be practically valueless.

DRY BLOWERS AT WORK.

Reproduced by courtesy of T. A. Rickard, Esq.

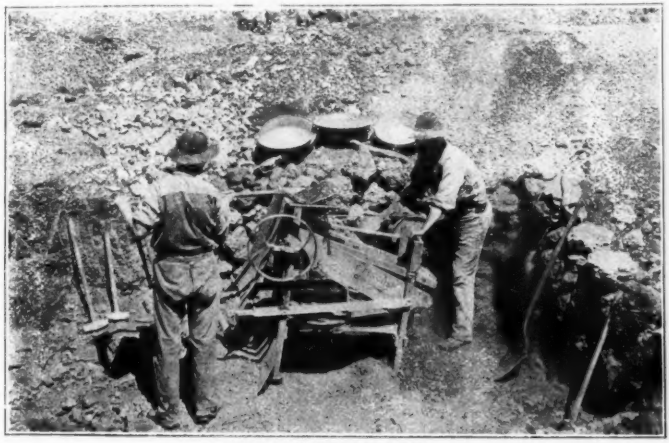
Alluvial Workings.—The gold obtained from this class of deposits has mostly been got from the loose dry surface-alluvials, by the method peculiar to Australia, known as "dry-blowing." For its success, it requires most careful manipulation when the gold is finely divided; but in experienced hands it gives fairly good results. That a good deal of gold is lost, however, is proved by the refuse-heaps of the dry-blower, which average in many places 10 pennyweights to the ton by assay, left standing after the ground has been turned over.

In the absence of water, which prevents the employment of the cradle, tom, or sluice box, employed by the placer-miner in other countries, it is designed to utilise the agency of wind in place of water; and in the skilful hands of the "prospector," this performs the function of sizing, classifying, and thereby concentrating the material a step further than nature has already done. The perfect dryness of the dirt, and the heat imparted to the iron-pan by a tropical sun, are factors which are indispensable for its success, imparting a mobility to the material which Mr. T. A. Rickard has aptly compared* to "the behaviour of a charge in the roasting-furnace, in which the hot air cushions each particle so as to give the mass an apparent fluidity." He also points out in the paper referred to that much depends on the strength and uniformity of the wind. Fortunately for the dry-blower, there is generally a light breeze, except during sultry days in the

*The Alluvial Deposits of Western Australia. Trans. Am. Inst. of Mining Engrs., 1898.

height of summer and on the cloudy mornings in the wet season, both of which times of year are unfavourable for operations of the kind. The deposits worked in this manner are usually "patchy," and frequently lie at the head of shallow gullies, which start from ridges where a quartz vein outcrops, below which gold has been picked up on surface; and as Mr. Rickard remarks: "The distribution of gold in these deposits reminds one of its position on a vanning shovel. It may be traced up to the outcrop which yielded it, or it may be scattered in the sand for half a mile; but the rich and only workable part of the deposit will ordinarily be found at a distance of 30 or 40 feet from the reef." Doubtless, however, as previously explained (in last month's article), in certain instances the gold is derived from mere stringers and auriferous deposits other than quartz veins, and therefore the existence of rich alluvials does not always lead to the discovery of what can be strictly termed "a reef" in the immediate neighbourhood of deposits of the kind.

After the alluvial has been well shaken up, so as to bring to the surface the large lumps, which the "prospector" examines and skims off, dry-blowing, in its most primitive form, consists of dropping the "dirt" from a height, from one "dish" to another, the dust and finer particles being blown away in falling 4 or 5 feet through the air, whilst the gold and coarser gravel are caught in a second "pan" set on the ground at the miner's feet. He stands so as to face at right angles to the wind, placing the lower "pan" on a piece of coarse



DRY BLOWERS AT WORK.
Reproduced by courtesy of T. A. Rickard, Esq.

canvas, so as to catch any fine gold blown to one side over the edge of the "pan." This process is sometimes repeated several times, although once may suffice, shaking up the coarse lumps in the full pan on the ground so as to bring them to the surface again, picking them out, and pouring the residue back into the empty pan, as before.

The next stage is to toss the dirt up and down in the pan, holding the pan in a slanting position, away from the operator, and jerking it back, so as to throw the dirt from the front to the back of the dish, thus winnowing it still further. Then once more shaking the pan, with a vanning movement, he brings the lumps to the top and skims them off. When thus reduced to a small quantity of "fines," the auriferous residue is still further shaken down, like the contents of a dish, when panning it in water, and with the pan tilted forward, the miner raises it to his mouth and completes the process by blowing off the remaining light sand.

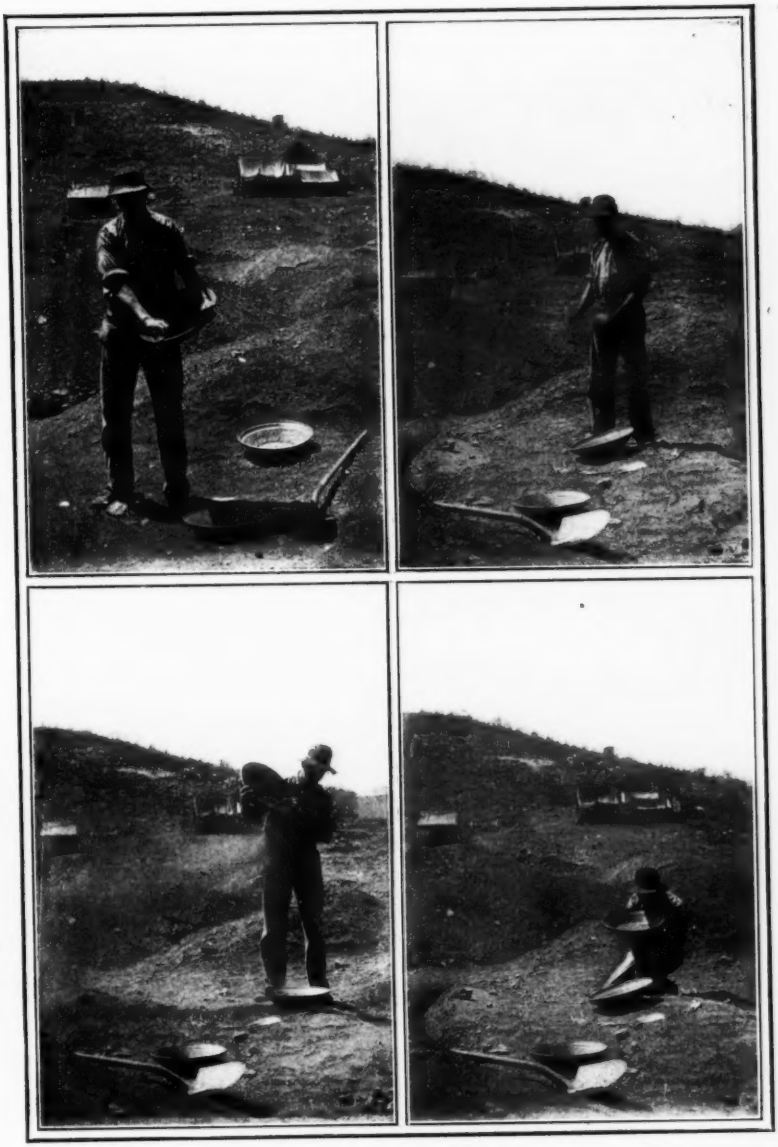
After this process of concentration is finished the gold is seen fringing the edge of the iron-sand; any nuggets or pieces coarse enough to "spec" are picked out, and the "fine gold" is either washed out with water in the usual way or collected with the moistened end of the miner's thumb.

The operations of the dry-blower, above described, are shown in the accompanying illustrations on pages 1030-1035, which are reproduced from the papers of Messrs. Rickard and Geo. J. Bancroft.*

This slow and laborious process is frequently superseded by a "machine" for sizing the material, operated on the same general principles, which, in its simplest form, is known as a "shaker," owing to the shaking motion imparted to it.

It consists of a couple of slanting frames (covered with screens of different sizes—generally 12 or 18 mesh—and provided with cross riffles), fixed on legs in such a way as to allow the miner to shake the material backwards and forwards. The dirt, which is fed on to the head of the frame through a hopper fitted with a sheet-iron bottom punched with 1-inch holes, passes down the inclined screens, the finer particles falling through, the coarser ones being discharged over the end, and the gold grains and nuggets accumulating behind the riffles. The "fines" collected underneath the frame are subsequently treated by hand, by the method first described. Such a machine measuring 4 feet by 2 feet will put through about 5 tons of loose dirt in 7 hours.

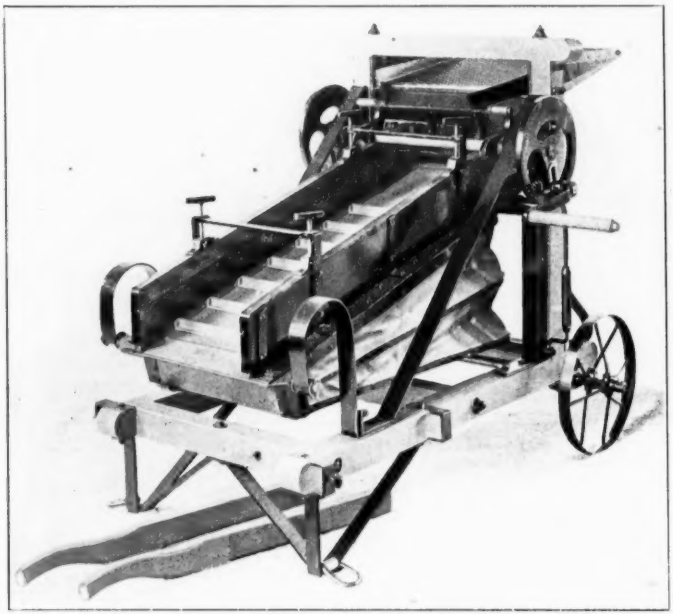
*Kalgoorlie, Western Australia, and Its Surroundings. Trans. Am. Inst. of Mining Engrs., 1898.



A DRY BLOWER AT WORK.

By courtesy of T. A. Rickard, Esq.

A more elaborate contrivance to fulfil the same object is illustrated in Mr. Rickard's paper and consists of a series of flat trays with sieve bottoms, hung on a tripod; several other machines of the same char-



WOOD'S DRY BLOWER. PROSPECTING-MACHINE TYPE.
Fraser & Chalmers, Chicago, Ill., U. S. A.

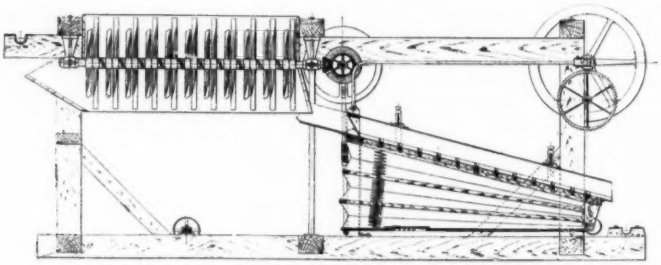
acter are provided with bellows, to produce an artificial air current, in order to blow away the finer worthless material. One of the most effective of these contrivances, I believe, is "Wood's dry placer-miner,"* manufactured by Messrs. Fraser & Chalmers.

Usually in such machines the bellows and sieves are worked in synchronism, being coupled together and driven by belting by means of a fly-wheel turned by hand. A machine of this sort, which weighs,

*A large size machine requires two horse-power to operate it, and is mounted on an oak frame which covers a ground space of 5 feet by 13 feet 9 inches, weighs 2,600 pounds, and is stated to have a capacity of 10 cubic yards of dry screened gravel per hour, the gravel being fed to the machine from a disintegrating-box filled with revolving steel blades. The riffle-board has a shaking motion of 150 strokes per minute, which helps to settle the gold to the bottom, and the blast of the bellows can be regulated so as to make it stronger or weaker. The prospecting machine has a length of 4 feet, width of 2 feet, and height of 3 feet 10 inches; weighs 300 pounds, and its capacity is given as 1,500 to 2,000 pounds per hour.

HANNAN'S FLAT AT KALGOORLIE. THE SCENE OF MUCH SUCCESSFUL DRY BLOWING.

By courtesy of T. A. Rickard, Esq.



WOOD'S DRY PLACER MINER. SECTIONAL VIEW SHOWING CRUSHING, SHAKING, AND BLOWING ARRANGEMENTS

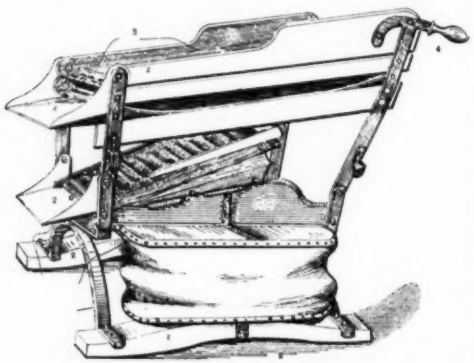
Fraser & Chalmers, Chicago, Ill., U. S. A.

according to Mr. Rickard, 124 pounds, and puts through 10 to 14 tons a day, costs in Freemantle about £16, and can be carried on poles by a pair of men.

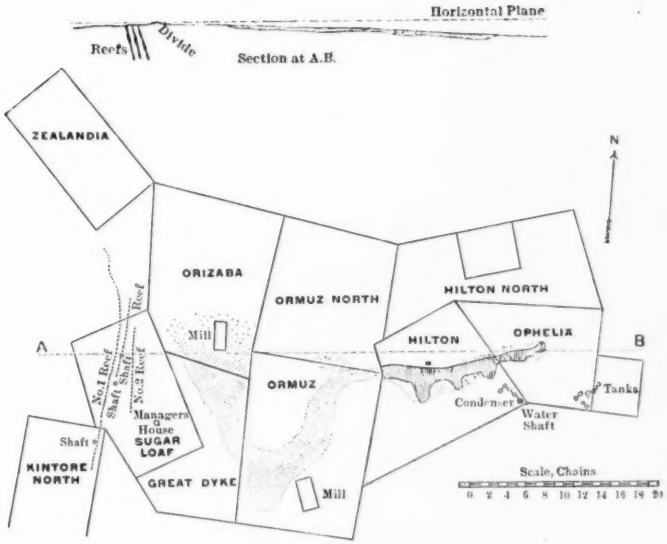
A little machine known as the "pneumatic prospector," made by P. P. Cuplin, of West Bend, Iowa, might possibly be worth the attention of prospectors. It measures 6 by 11 by 14 inches and only weighs 10 pounds; it seems extremely portable, and is said to give a clean prospect, equal to careful panning.

A larger machine, called a "pneumatic separator," which weighs 160 pounds, it is claimed, is able to handle 20 to 30 cubic yards of gravel per day, and to save fine and coarse gold and nuggets of any size, free from black sand.

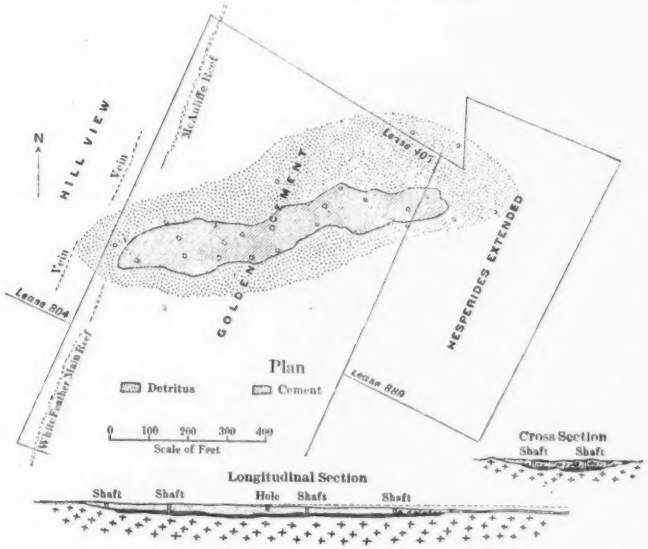
The Cement Deposits.—Leading, as they have done, to the discovery of the more valuable "formations," in consequence of the fact that these latter did not outcrop at the surface (on account of the comparative softness of the lode material), the cement-deposits may be regarded as of the very greatest importance, in particular in this field, notwithstanding that the amount of gold they have returned in the aggre-



LORDEN'S DRY-BLOWING MACHINE.



CEMENT DEPOSIT, KINTORE, WEST AUSTRALIA.



THE CEMENT DEPOSIT AT KANOWNA.

The cuts on this page are reproduced by courtesy of T. A. Rickard, Esq.

gate is comparatively trifling. Underlying the red loam on the flats, which covers extensive areas, a considerable thickness of blue clay is met with in places, whilst on the outskirts of the hills surrounding them it is only of slight thickness and rests directly on the auriferous series.*

The first discovery of cement† was made some 3 or 4 miles south of the earlier alluvial find, near what is now known as the "Boulder Township," where the prospectors found rich patches of surface-dirt and cement and located several strong quartz croppings, on the strength of which the Great Boulder and other leases were pegged out.

These quartz veins were larger than those previously referred to at the north end of the field, but turned out equally poor and uncertain, and it was ascertained by sinking a shaft, known as No. 3, or Gamble North's, in the eastern part of the Great Boulder ground, that the vein pinched at a depth of 75 feet. A trench was then started to cut a big iron-stone outcrop, which forms a hillock behind the present co. .pany's office, but the iron-stone reef was found to carry only about 12 pennyweights of gold per ton, which was too low-grade in those days to pay. This trench, when extended further west, however, penetrated another vein, which had no outcrop visible, but proved to be the cap of the eastern portion of the magnificent lode, which has been worked up to the surface. The formation, as shown in this open-cut, was nearly 20 feet in width, buried under some 2½ feet of cement.

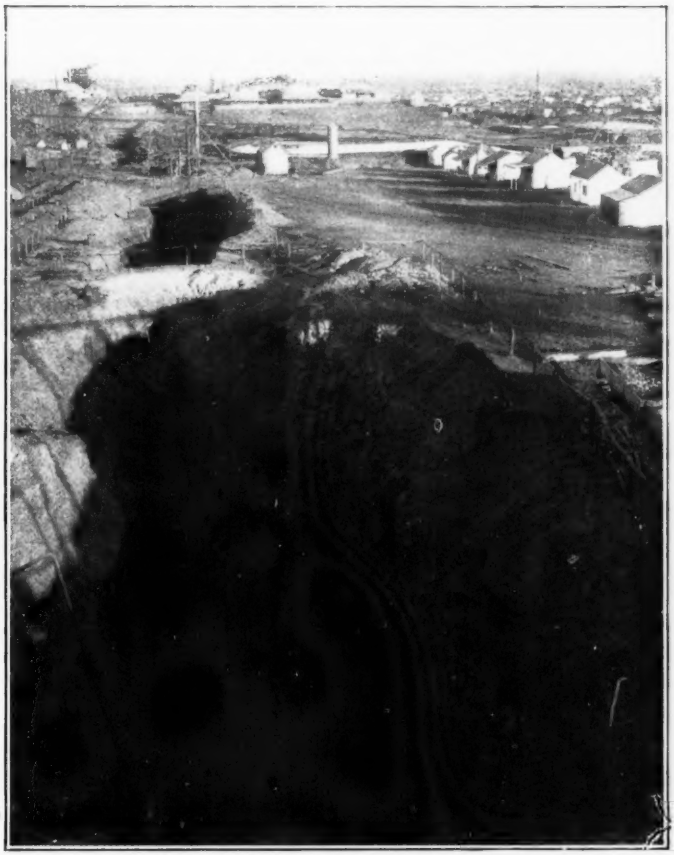
The Great Boulder Perseverance had a somewhat similar beginning. The vein in the old No. 1 shaft turned out poor and was abandoned, but the rich formation that traverses the adjoining Lake View Consols Lease was found later on, capped with cement, which concealed its existence, and it has since been stoped to daylight in the huge open cutting depicted on the opposite page.

At the beginning of 1898, great excitement was caused by the pegging out of a number of claims on the Ivanhoe Venture Lease, by Bray and party and other alluvial men, and in the course of the year 639 ounces 5 pennyweights were obtained from some 247½ tons of cement crushed.

What may also prove, perhaps, an important find was made in May, 1899, in the northern part of the field on Lease 1,260 E, on the property of the Kalgoorlie Mining Developments Co., Ltd., where the first

* H. P. Woodward. The So-called Lode Formations of Hannan's and Telluride Deposits. Op. Cit. p. 6. Trans. Inst. of Mining and Metallurgy, 1897, p. 15.

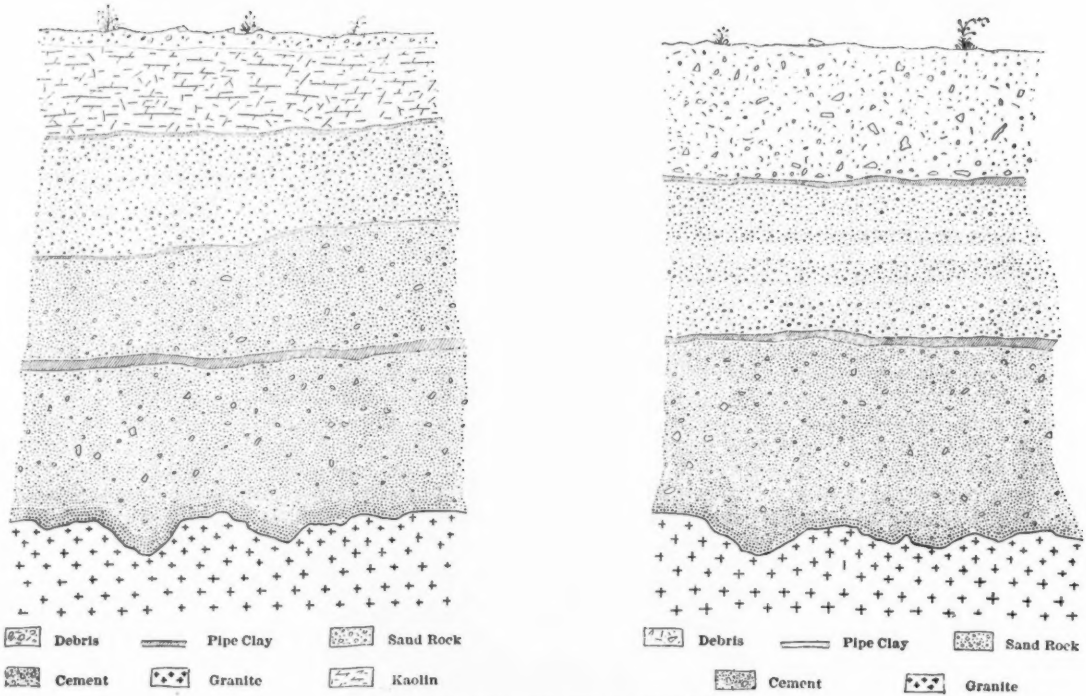
†T. A. Rickard. The Minerals Which Accompany Gold and Their Bearing Upon the Richness of Ore Deposits. Trans. Inst. of Mining and Metallurgy, 1898, p. 207.



OPEN CUT, GREAT BOULDER PERSEVERANCE MINE.

shaft sunk (known as No. 1), bottomed on an iron-stone "wash" (mixed with pug and concretionary nodules of calcite), about 10 feet thick, at a depth of 82 feet. Other shafts sunk in this lease have proved the existence of a gutter of cement running apparently in a northeast and southwest direction at a depth of about 105 to 108 feet. This cement averages about 2 feet in thickness, whilst the pay-channel so far varies in width from 12 feet to 31 feet 6 inches, and prospects from 15 pennyweights to an ounce and a half.

Three claims located upon it up to the end of December, 1899, produced as follows:



SECTIONS IN THE OPEN CUTS AT KINTORE.

By courtesy of T. A. Rickard, Esq.

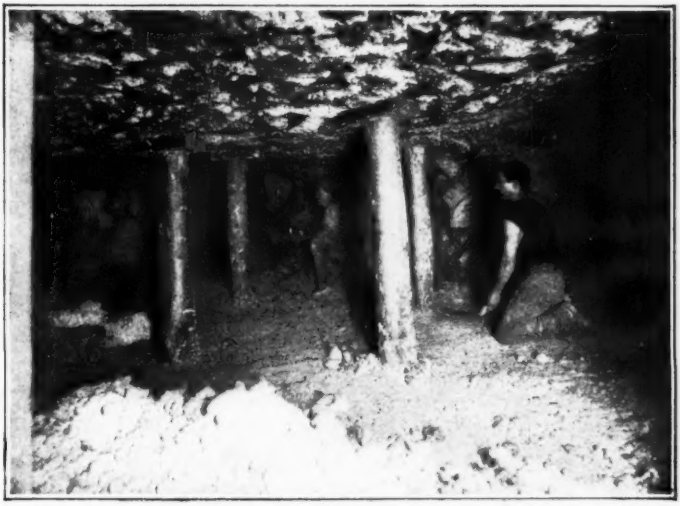
(1) 444 tons of cement crushed yielded 608 ounces 14 pennyweights 12 grains of gold .

(2) 429 tons yielded 427 ounces 6 pennyweights 20 grains.

(3) 350 tons 10 hundredweight yielded 486 ounces 11 pennyweights 6 grains.

The bullion varies in value from £3 18s. 6d. to £4 1s. per ounce.

Several strong outcrops have also been uncovered in course of working, one of which carries a dark bluish quartz, and from the number of angular pieces of rich "float" of a similar description that have been found it appears not unlikely that following this lead up may result in the discovery of a payable reef, or reefs, in this section of the field. The cut on this page, from a view taken underground in these workings, affords an excellent representation of the way in which mining is carried on in deposits of this nature.



WORKINGS NO 1, ALLUVIAL CLAIM, KALGOORLIE.

Topographical Features of the Field.—Hannan's Belt, as it is frequently called (in the centre of which Kalgoorlie is situated), is a long, narrow strip of country, some 8 or 10 miles in length, folded along an axial line which runs in a northwest and southeast direction and has a width of about 2 miles. In the northern half of this district, a number of leases have been taken up at various times, on quartz lodes which have hitherto proved of little or no value, whilst the group of mines which have rendered the district famous are of a totally distinct char-

acter and lie about 4 miles southeast of Kalgoorlie, in the immediate neighbourhood of the Boulder Township, before referred to.

All the richest mines at the southern end of the field are grouped around the flanks of an isolated ridge* and several conical hills of about the same height to the southwest of it, which break up the prevailing level of the surrounding flats; so that, proceeding from Kalgoorlie along the Boulder road, you gradually though slowly ascend, until you reach the foot of the Australia Hill—the ridge referred to. The north end of this ridge (which is occupied by the Kalgoorlie lease), passes southward through the Associated, Lake View, and Lake View South leases, and springs rapidly up from 150 to 200 feet above the rising ground surrounding it.

I lay stress on this feature of the topography, because it seems to me probable that these hills (the summits of which were, many of them covered originally with ironstone-gravels, passing in places into compact limonite), mark the principal centres where, through the pressure of the underlying plutonic rocks, or volcanic agency, the main series of igneous eruptives (that form such an important feature of this section of the field, and to which the telluride deposits seem to owe their origin), burst their way through to the surface, and owing to their superior hardness have since escaped being leveled by denudation.

The direct effect of these subterranean disturbances where they were most active may well have been to crumple up, fault, and elevate the rocks in the neighbourhood, and it is probably, therefore, owing to this fact that the largest and richest ore-bodies found have been discovered on or in the neighbourhood of the broken hilly ground above referred to, which dominates the surrounding central portion of the basin, running in a direction more or less parallel with and midway between the longer axes of the main folds that hem it in on the east and west. South of this metalliferous area, the general level of the basin falls gradually towards Hannan's Lake, a large depression or clay-pan, in which water is only seen after a heavy rainfall, which is of rare occurrence; though a considerable quantity of salt water is conserved in the alluvial sands and clays which fill its bed.

My next paper will be devoted to the water problems which are met in the Australian gold-fields—the peculiar difficulties of the region and the means of relieving them.

* NOTE.—This ridge is not of uniform height, however, being crossed by several "necks" which divide it into a series of "hogs-backs."

INFLUENCE OF THE EXPOSITION ON THE FRENCH IRON AND STEEL INDUSTRY.

By Henri Guérin.

France has two distinct claims upon the interest of iron and steel producers—first, that conditions have always imposed upon French iron masters the closest study of economy; second, that she is a consumer of iron and steel, and therefore a profitable study for the countries exporting those materials. M. Guérin was for twelve years closely interested in the production of structural materials in France, and hence is master of his subject.—THE EDITORS.

HE industry of iron and steel in France may be said to have commenced its real development with the first French exposition of 1855, and a gradual progress was shewn at the successive expositions of 1867, 1878, and 1889; but at the present time the industry has taken a veritable boom. There is no doubt that especial efforts were made at the exposition just closed, and the remarkably fine exhibits of the various establishments were the results of the ambitious competition of leaders in the metallurgical industries.

The natural mineral riches of France are hardly such as to enable her to compete with other more favoured countries in the production of cheap pig iron, or to introduce the most recent devices invented for its manufacture; but the extreme care which her manufacturers and scientists have given to all the details of their work has produced important results. As we shall see further on, each international exposition, and especially the international exposition of 1900, has marked a period of prosperity in the siderurgical industry.

In order to grasp the present conditions, it seems advisable to recall briefly some of the preliminary features of the processes of the manufacture of iron and steel, and to emphasise particularly the most interesting facts which have been manifested at the epochs of the successive expositions. After this brief *résumé* the reader will be better prepared to judge of the progress evidenced by the exposition of 1900. Having thus examined the purely technical side of the subject we shall then be in a position to discuss its economic features, and be able to formulate certain conclusions which follow.

The early metallurgists commenced by producing iron directly in a low furnace, using the richest and most fusible ores, together with

natural fuel. Later on came the introduction of the high furnace, permitting the production of wrought iron indirectly, that is, by first making cast iron. In the higher furnaces wood was replaced by coal, alternate layers of ore and fuel being used, and a much greater product was obtained from the ore. By means of improvements in the blast, higher temperatures were produced, and, by creating the most favourable conditions for effecting the combination of oxygen and carbon, the reduction of the iron from the ore became more and more complete and economical. The fused iron being run directly into the sand was allowed to cool in the form of pigs. The pigs were then treated in refining furnaces in which the combined carbon was separated by oxidation, producing blooms ready for the operations of puddling, rolling, and forging. If it is not desired to produce wrought iron, the pigs are remelted in the cupola for the production of castings. The product of the cupola is also used as the material for the production of cast steel, as we shall see hereafter. Steel is also produced by the carbonisation of wrought iron in special furnaces, the product being called cemented steel, but the processes most generally employed at the present time are based upon the decarburisation of cast iron, the methods being modified according to the resistance and elasticity desired in the product. Without going into further details of the elementary principles, the displays at the various expositions will now be considered.

The most conspicuous novelty shown at the exposition of 1855 was the employment of the discharge gases from the blast furnace for heating the blast; especial attention being directed to this subject in the discussions at that time as constituting a new and important advance in the utilisation of heat formerly wasted. In 1855 also appeared improvements in rolling-mill construction which enabled rails and structural sections in wrought iron to be produced to an advantage which, while not comparable with the present methods, was nevertheless a marked advance over previous processes. The Creusot works and the Petin-Gaudet works at that time made their first attempts at the manufacture of armour plates of steel. There were also exhibited some important examples of steel forgings, notably a cranked axle for a locomotive. It may be noted that at this period the only methodical attempts at testing were a few instances of impact test.

At the following exposition, in 1867, a much more complete display was made. The conspicuous feature was the prominence given to the then newly-introduced Bessemer process for making steel. This process consisted in the decarburisation of cast iron by means of

a powerful blast of air blown through the molten metal in a peculiar form of vessel known as a "converter." Examples of this steel in the form of rails were exhibited by the establishments of Imphey, Petin-Gaudet, and Terre-Noire. At that time the importance of a knowledge of the chemical composition of pig iron and its bearing upon the product became realised. This was followed by the introduction of testing methods for determining the resistance and elongation of the material. The Bessemer process gave satisfactory results only after it was modified by the addition of manganiferous iron at the close of the operation, and by the use of irons carefully selected with regard to their freedom from phosphorus and sulphur. These early undertakings marked a new era and a fresh starting point for the work of metallurgists. At this time also the importation of high-grade ores into France from Algeria and from Spain was inaugurated, and at the exposition of 1867 were shown some remarkable examples of iron and steel forgings, especially for military and naval purposes.

In 1878, at the next international exposition, it might have been supposed that the disastrous effects of the war of 1870 would have been apparent in a retardation of metallurgical progress; but no such effect was evident, the displays at the exposition showing that in preparing for it the various establishments had exercised especial efforts to regain the lost time. The result was admirable, for the metallurgical exhibits in 1878 not only demonstrated the immense advance which had been made in the metallurgical arts in the short period which had intervened since the previous display, but were also prophetic of the immediate progress which followed.

The new process for the manufacture of steel introduced at the exposition of 1867 caused an increased demand for the production of pure pig iron at a moderate cost. This stimulated the development of the blast-furnace improvements, especially appearing in the design of apparatus for the production of the hot blast, among which may be mentioned the devices of Siemens, Cowper, and Whitwell; the use of these resulting at the same time in a reduction in manufacturing cost and an improvement in quality of product. The Firminy works, as well as those at Terre-Noire, took the initiative in the production of sheet steel by the Siemens-Martin process, this offering the advantage of producing a steel of high degree of elasticity and uniformity, and at the same time permitting the use of an ordinary grade of pig iron.

At this exposition appeared also steel castings, both hard and annealed, from patterns, as well as malleable-iron castings. Many

heavy forgings were also exhibited, including steel armour plate, the demands for such work influencing the construction of an important tool, the 100-ton steam hammer, the whole being in response to the demand for heavy steel work for ordnance purposes.

While the exposition of 1878 was the occasion of the display of a new industry in the development of the open-hearth process, that of 1889 showed the results of improvements made in the Bessemer process. By modifying the character of the lining of the converter (the Thomas-Gilchrist process), basic steel was obtained, this method furnishing the long-sought process of dephosphorising pig iron. Two millions of tons of basic steel represented the production of the whole world, the Department of Meurthe and Moselle in France furnishing 200,000 tons. The Siemens furnace was also greatly improved, the roof being constructed of highly siliceous bricks and the sole covered with basic material.

The conspicuous feature of the exposition of 1889, however, was the production of metallic alloys both in the high furnace and in the crucible. In 1867 the proportion of manganese in the spiegeleisen rarely exceeded 8 to 10 per cent., while in 1878 a content of 88 per cent. was reached. In 1889 alloys of iron with chromium, silicon, and manganese were shown. One alloy, made at the Holtzer establishment, contained 80 per cent. of chrome and 10 per cent. of carbon. In the blast furnaces at Marseilles the maximum proportion attained in the respective alloys were 65 per cent. of chrome, 54 per cent. of silicon, and 89 per cent. of manganese. In regard to the industry of steel castings, the principal novelty at the exposition was the small converter used in connection with the Robert process, by which a great number of small castings could be made without the necessity of installing a full-sized Bessemer plant. It is probable that the era following the exposition of 1900 will witness the erection of many new steel furnaces of this type.

The improvement in the elastic quality of steel, originating at this period, has produced remarkable results. In the exhibit of the Firminy works were shown examples of mild steel, having a resistance of 40 kilogrammes per square millimetre (57,000 pounds per square inch), with an elongation of 30 to 35 per cent. Engineers began to perceive that it would now be possible to use steel plate in the construction of steam boilers with safety. Steel wire was also shown at the exposition of 1899 by the Châtillon-Commentry works, some of the exhibits being remarkably fine. Armour plate and war material generally formed also a conspicuous feature of the exposition.

showing especially the progress realised by the employment of the alloys of steel with other metals.

To complete this review of the exposition of 1889 a statement is appended showing the quantity of cast iron, wrought iron, and steel used in the construction of the various buildings of the exposition; this serving as a point for comparison with the similar use of material in connection with the exposition of 1900:

Building.	Weight of material, metric tons.
Palace of Machinery	12,761
Palace of Fine Arts and Liberal Arts	8,027
Palace of Diverse Industries	8,337
Central Dome	1,091
Pavilion of the City of Paris	180
Gallery of Class 61	135
Gallery of Agriculture	789
Palace of Alimentary Products	173
Pavilion of the Ministry of Public Works	152
Pavilion of State Manufactures	57
Palace of the Colonies	58
Eiffel Tower	7,347
Total	39,107

The exposition of 1889 seemed to have demonstrated that all the efforts to produce iron and steel in great quantity and at the same time of excellent quality had resulted in the maximum output, but the exposition of 1900 far surpassed all its predecessors in this respect. Space is here lacking to enter into all the details of the various exhibits, and only the three principal lines of work can be examined successively. These leading features are:

1. The development of the basic process of making steel.
2. The increased use of the Siemens-Martin furnace.
3. The tendency to substitute steel castings for iron castings and forgings.

The production of steel by the Thomas process, commonly known as the basic process, has quintupled since the exposition of 1889, while the output of the acid process has only doubled. This increase is partly due to the introduction of the "mixer," which, as its name indicates, acts by the mingling and consequent regulation of the charges of cast iron in such a manner that the sulphur, which would interfere with the quality of the steel, gathers on the surface of the liquid metal as a sulphide of manganese. Besides this it has been demonstrated that coke, introduced directly into the steel, produces

a hard steel, highly carburised and free from manganese, well adapted for the production of rails by the Thomas process. Finally, the slag and waste products of the process form valuable fertilisers because of their richness in phosphoric acid.

The Siemens-Martin furnace possesses the advantage of great adaptability, and it is not rare at the present time to find such furnaces of 45-tons capacity. Still further, the Bertrand-Thiel process employs two basic furnaces, of which the upper one is used for the elimination of the silicon and the phosphorus, the decarburisation being effected altogether in the lower one.

Steel castings made their appearance in 1889, but their employment was very limited because of high temperatures demanded, because of the great shrinkage, and because of the numerous blow holes which appeared in castings above a moderate size. At the present time these difficulties have been overcome, as could readily be seen in the specimens shewn at the exposition. Three processes have been employed in the production of steel castings: 1. The crucible method, which has been improved by the use of judicious additions of nickel, aluminum, etc., to the product; 2. The use of a special form of Siemens-Martin furnace adapted to the production of large castings, enabling either hard or soft castings to be made. The following notes concerning these products were presented by M. Tissot at the Metallurgical Congress of 1900:

Percentage of carbon in steel	0.25 to 0.50
Percentage of manganese in steel	0.40 to 1.00
Percentage of silicon in steel	0.20 to 0.45

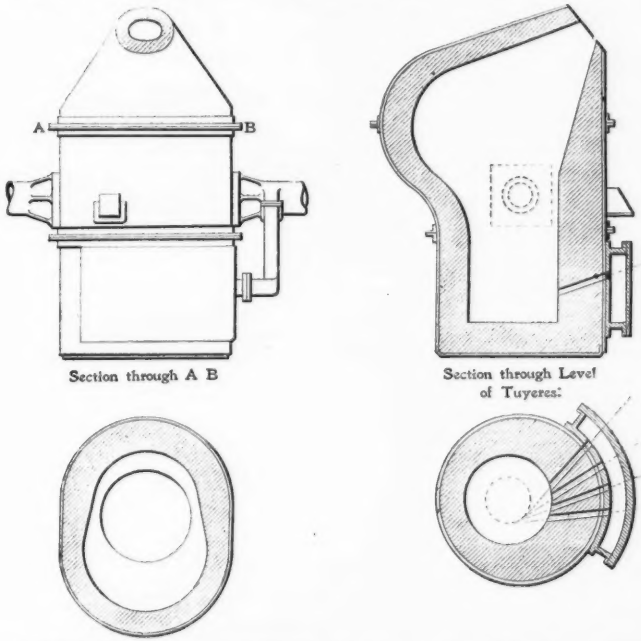
Tests.	Soft Steel, Basic.	Soft Steel, Acid.	Hard Steel, Acid or Basic.
Resistance to tension	64,000 lb.	70,000 lb.	110,000 lb.
Percentage of elongation	25 to 28	25	8 to 12
Impact resistance	42,500 lb.	28,500 lb.	10,000 to 11,000 lb.

The drop test consisted of a ram of 18 kilogrammes weight (about 40 pounds) falling from a height of 2 metres (6 ft. 6¾ in.) upon bars of 30 × 30 mm. (1.18 inches × 1.18 inches) spaced 160 mm. (6.3 inches) between supports.

3. The use of small converters. The Robert converter, already referred to as having appeared in 1889, gives a milder steel than that produced in the Siemens-Martin furnace. By this method steel having a resistance of 57,000 pounds and an elongation of 35 per cent., to a steel of a resistance of 114,000 pounds and an elongation of 7 to 8 per cent., can be made. Steel of this kind has been used for the bodies of electric generators, of which numerous examples were found at

the exposition. The composition showed a content of carbon, 0.14 per cent.; manganese, 0.34 per cent., and silicon, 0.06 per cent.

Another form of converter, patented by T. Levaz, has been used by the Société des Aciers de la Meuse, at Stenay, who exhibited steel castings for the frames of bogie trucks for electric tramcars, gear wheels, clutches, a hydraulic motor 3 metres in diameter, engine castings, cranked axles, and also furnished the frames of many of the generators shown in the department of electricity.



THE LEVAZ CONVERTER, FOR MAKING SMALL CASTINGS DIRECT FROM THE CONVERTER.

A sketch of this converter is given, and it appears to possess many advantages. The pocket formed in the upper portion is intended to receive the product at the close of the operation, and permits an intimate mixture of all the molecules of the steel with the various materials which may be added. These converters are made of a capacity of 1,600 to 1,800 kilogrammes (3,500 to 4,000 pounds), and the average duration of the blow is about 12 minutes. The arrangement of the tuyeres, as shown in the sketch, imparts a rotary motion to the

charge, well adapted to secure a thorough mixing. As an example of the advantages of the use of steel castings in construction it is only necessary to refer to the voussoirs used in the arches of the Alexander III. bridge, this structure containing no less than 2,500,000 kilogrammes of steel castings. It was the use of this material which made it possible to solve the problem of constructing a single arch across the Seine which should afford an unobstructed waterway for navigation and at the same time avoid elevating the roadway to an extent which should interfere with the perspective of the esplanade of the Invalides. The employment of steel voussoirs permitted the construction of the very flat arch without requiring undue thickness at the key.

It would exceed the limits of the present discussion to go further into details of individual exhibits. It is only necessary to mention the improvements in tools made possible by the use of chrome and tungsten, the manufacture of seamless tubing, the rolling of weldless tires, the many artistic castings, the variety of drop-forgings, the military and naval material, the 50-ton electric locomotive of Creusot, etc.

We may complete this enumeration by giving, from special information furnished by the management of the exposition, the classified weights of metal construction work used in the buildings of the exposition of 1900, and in the Alexander III. bridge.

Structure.	Weight, in metric tons.
Large Palace of Fine Arts	15,803
Small Palace of Fine Arts	616
Palace of Horticulture	770
Monumental Entrance	188
Lower Palace	711
Palace on Fabert side	1,596
Palace on Constantin side	1,433
Palace of National Manufactures	2,083
Rearrangement of the Palace of Machinery	2,129
Palace of Electricity	4,449
Palace of Chemical Industry	2,399
Palace of Mechanics	2,963
Palace of Civil Engineering	4,560
Palace of Textile Fabrics	4,687
Palace of Education	1,815
Palace of Mines	2,514
Alexander III. Bridge—	
Steel Castings	2,359
Structural Rolled Steel	2,823
Cast Iron	270
Temporary Erecting Works	400
Total	54,568

It is only necessary to mention also the important public works involving a great amount of metallic construction and directly resulting from the exposition; these are:

1. The Metropolitan Railway of Paris (first portion only constructed).

2. The new lines of the Western Railway of France.

3. The prolongation of the Orléans railway on the Quai d'Orsay.

Having thus generally reviewed the state of the industry of iron and steel manufacture in France, it will be appropriate to examine the economic and statistical side of the subject.

In order to form a correct opinion of the prosperity of the siderurgical industries of a country, the best index to consult is the production of cast iron. The tonnage of cast iron produced in France has risen from 1,528,246 tons in 1878 to 2,534,427 tons in 1898; an increase of 1,006,181 tons, or 66 per cent. The total production of steel has risen from 269,181 tons in 1878 to 1,138,633 tons in 1898. This increase is partly explained by the introduction of the Bessemer and Siemens-Martin processes.

As will be seen upon examination of Diagram A, the production of wrought iron has remained stationary, or even declined, during a number of years, while the output of steel increased, and in 1895 passed that of wrought iron. As is well-known, the first patents of Thomas for basic steel were taken out in 1875. It was in 1880 that

Year.	Metric Tons. Cast Iron.	Wrought Iron.	Steel.
1885	1,630,648	782,431	553,839
1886	1,516,574	766,556	427,589
1887	1,567,622	771,610	493,294
1888	1,683,349	816,973	517,294
1889	1,733,964	808,724	529,302
1890	1,762,196	825,369	581,998
1891	1,897,387	833,409	638,530
1892	2,057,258	828,519	682,527
1893	2,003,096	808,171	664,032
1894	2,069,714	785,781	674,590
1895	2,003,868	756,793	714,523
1896	2,339,537	828,758	906,817
1897	2,484,191	783,966	994,801
1898	2,534,427	801,543	1,138,633
1899	2,567,888	842,775	1,253,701

PRODUCTION OF CAST IRON, WROUGHT IRON, AND STEEL IN FRANCE.
These are the figures represented in graphic form on page 1051.

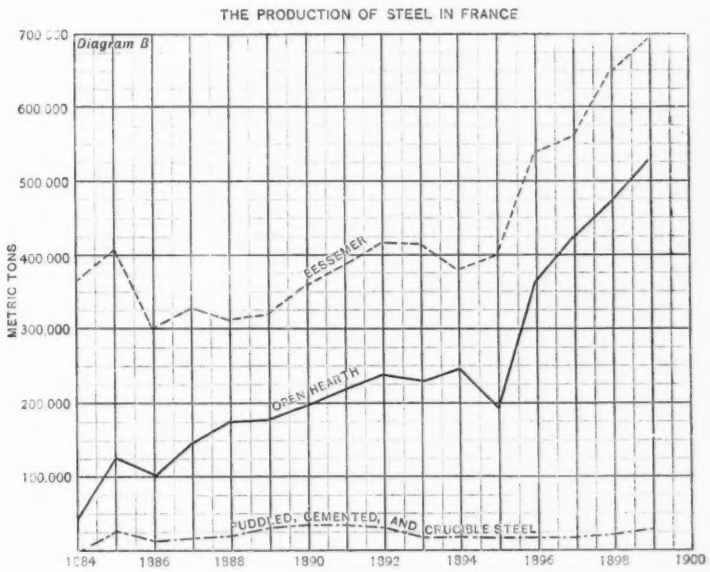
the process was practically introduced into France, when 4,771 tons of steel were produced, while the product in 1892 was 287,528 tons, and at the end of these 12 years the total quantity of basic steel produced was 1,820,672 tons. The following table will show the increase in the production of steel rails and the corresponding diminution in the production of iron rails.

Year.	Metric Tons. Steel Rails.	Iron Rails.	Year.	Steel Rails.	Iron Rails.
1869	50,025	133,403	1883	340,679	655
1870	38,275	81,363	1884	284,031	.....
1871	18,063	77,985	1885	249,416	.....
1872	52,199	103,963	1886	170,595	.....
1873	64,097	130,531	1887	108,898	.....
1874	102,227	125,664	1888	93,868	.....
1875	120,660	96,886	1889	58,096	.....
1876	130,681	57,935	1890	66,844	.....
1877	137,147	43,880	1891	112,857	.....
1878	196,240	39,232	1892	163,840	.....
1879	202,434	27,604	1893	199,328	.....
1880	191,776	16,777	1894	110,609	.....
1881	231,334	8,064	1895	85,249	.....
1882	284,069	6,930	1896	77,104	.....

THE PRODUCTION OF IRON AND STEEL RAILS IN FRANCE.

After the exposition of 1889 the railway companies began to use heavier rails, weighing 40 to 45 kilogrammes per metre (80 to 90 pounds per yard). The exposition of 1900 has shewn no similar tendency, the effort being toward an improvement in quality rather than an increase in weight. Thus among the exhibits of the steel works of Longwy was shown a rail of 43 kilogrammes per metre (82 pounds per yard) which gave under test a resistance of 89 kilogrammes per square millimetre (126,588 pounds per square inch) with an elongation of 13 per cent.

The remarkable increase in the production of cast iron and steel



Year.	Metric Tons. Bessemer.	Open Hearth.	Puddled and Forged.	Cemented.	Crucible.
1884	365,436	40,910	.....	....	.....
1885	404,019	123,829	11,746	6,948	7,297
1886	300,165	101,406	9,837	1,512	6,384
1887	324,487	143,764	12,532	1,491	7,532
1888	310,012	172,487	13,118	1,342	9,409
1889	316,892	179,000	13,689	1,598	12,681
1890	354,194	193,189	16,382	1,301	13,377
1891	388,256	216,168	16,046	1,455	12,135
1892	412,534	238,224	13,129	1,385	11,500
1893	410,619	228,642	7,270	1,319	11,168
1894	377,976	248,369	6,958	1,238	10,968
1895	399,139	191,682	6,685	1,292	10,985
1896	534,995	359,543	6,892	1,347	10,249
1897	557,708	415,186	8,012	1,186	10,091
1898	646,550	460,617	6,672	1,110	15,411
1899	697,053	520,476	8,015	1,041	17,067

THE PRODUCTION OF STEEL IN FRANCE.

Presenting in tabular form the same data shown graphically above.

shown in Diagram B, beginning in 1895, is due not only to the improvements introduced in methods of manufacture, but also to the influence of the exposition of 1900 and of works undertaken in view of the exposition. It is interesting to note that a similar effect appeared at the approach of the exposition of 1889, the rise being evident

in 1886, although naturally less-marked than in the later case. In each instance the rise in output followed a previous decline, the advent of an exposition having proved sufficient to effect the change.

The influence of the exposition from a commercial point of view is manifest. According to data furnished by the Chamber of Commerce, the importations in 1887 classified under machinery and mechanics amounted to 43 millions of francs; in 1898 it passed 77 millions, and in 1899 it reached 89 millions. A similar increase is found in diverse products of metal, the importation rising from 23 millions in 1888 to 33 millions in 1899. The decline shown on the diagrams between the years 1892 and 1895 corresponds to the period of financial crisis, due to overproduction, which appeared in nearly all productive countries. This effect, however, was much more marked in Germany, England, and Belgium, than in France, where the output is much more carefully regulated with regard to internal consumption.

With regard to the question of prices, while the price of steel rails was 136 francs per ton in 1897, it has to-day reached nearly 200 francs, or about what it was in 1880. Nevertheless this rise, which began to appear in 1898, has not checked the demand, which has continued to develop.

In conclusion, it appears evident that the general effect of international expositions in France has been to develop a spirit of active competition, while the comparisons which are apparent when the efforts of this competition appear in exhibition give a very definite indication of the general direction in which advance has been made.

Apart from the direct effect of competition it may be observed that a result of the exposition of 1899 was the creation of modern laboratories for testing and research, which have paved the way for many of the advances since made, especially in connection with the various alloys which have done so much to further improvements in the manufacture of steel.

The exposition of 1900 showed the tendency of metallurgists to devote nearly all their attention to improvements in the production of steel castings. In view of the results which have been attained already in this branch of the art, so far as resistance and elongation are concerned, there is every reason to believe that this material will enter into the field of general structural work and probably cause great modifications in the art of metallic construction.

ACTUAL WORKING OF AMERICAN LOCOMOTIVES ON BRITISH RAILWAYS.

By Charles Rous-Marten.

A great deal has been said of the British builders' loss by orders placed with American firms for engineering work in Britain or her colonies. Very little has been said of the enormous gain to British trade and British investors from American ability to step into the breach, and to supply the materials, the tools, or the machinery which England's vast progress demanded and her overcrowded workshops could not supply. The purchase of American engines was purely a question of expediency; the working of the American engines is a study of the utmost utility to both nations. It is this practically valuable aspect of the matter that Mr. Rous-Marten considers.—THE EDITORS.

S will be remembered, in the July, August and September numbers of THE ENGINEERING MAGAZINE, in 1899, I dealt at some length with the difference between American and British principles and methods of locomotive building, in special relation to the orders which had been given by certain British railways for engines built in America. I then hoped to be able long ere this date to furnish some definite information as to the working of the American engines on the English railways which had ordered them at a time of strain and stress among the British manufacturing firms. But I have found it most difficult to obtain any specific data. In some cases my request for particulars has been most courteously but firmly refused, on the ground that the period was still "too previous" for any satisfactory conclusions to be announced. In other instances the matter was postponed indefinitely. So I am once more compelled to treat this subject from the standpoint of the independent observer, rather than from that of the "official report" supplier.

Privately I have taken a good many opportunities of noting the class of duty allotted to the American goods engines, and of observing how they *appeared* to perform their duty, and of seeking the opinion of their drivers as to their general efficiency. So far as could be judged from outside observation, the imported engines seemed able to take their turn quite satisfactorily with those of home construction and practically to do just as well. It is significant that recently the Americans have been put on one important class of work with freight trains which involves much faster running than that of the ordinary goods trains, while heavy loads—as loads are regarded in England—have to be hauled. This is apparently a distinct testimonial to their

efficiency. As for the drivers, they have had to overcome the chronic British prejudice against novelty of any kind, but now that they are getting used to handling an unfamiliar type of machine, they seem fairly well-contented with the American engines, making due allowance for the normal British habit of grumbling.

On the other hand, there has been a noticeable tendency in some quarters to "run down" the strangers, or—what is perhaps worse—to apologise for them and to explain that it was necessary to procure them, in spite of their shortcomings, to keep abreast of the traffic.

Probably the explanation of some adverse utterances may be found in the fact that the step taken by the companies in ordering the locomotives from abroad was an exceedingly unpopular one. The feeling of the British public generally was distinctly hostile, excepting only in the case of that section not only interested in the traffic which the engines were imported to facilitate, but also intelligently aware of the extent to which it would benefit through the non-detention of the goods in transit. The public generally, and the manufacturing and labouring public in particular, felt very strongly that, however badly the railway companies needed the engines, if the British makers were too busy to supply them the railways ought to wait patiently until they could get what they needed, and that it was disgracefully unpatriotic to go abroad for what could be made, sooner or later—especially later!—in Britain. Such a sentiment is apt to influence electoral votes. Most railway chairmen and directors are members of Parliament. Most members of Parliament are shareholders in railways. All are interested in politics. A matter like this large importation of foreign locomotives was apt to be brought forward at the general election, which has been pending for more than a year past, to the prejudice of those persons concerned, directly or indirectly, in the transformation. Therefore it clearly behooved those persons in their own political interests to lay all possible stress on its essentially makeshift character, and to avoid any defence on the basis of the importations having proved as efficient as the home-make.

In these remarks I am not pointing to anybody in particular. I am simply enunciating a fact. I declare unhesitatingly that it would have been most unpopular to assert or even admit, on the eve of the late general election, that these imported American engines could possibly be so good as British-built machines. Even through recording frankly the splendid work done under my own independent observations by the newest French locomotives I incurred strong personal unpopularity in certain quarters and received quite a collection of abusive

anonymous letters. Thus does national prejudice and miscalled "patriotism" enter into such a purely practical and scientific question as that of locomotive efficiency. It is droll, yet it is also most unfortunate in the true interests of the public in general and of the railway companies in particular.

But there is, of course, another side to the present question. It is quite certain that the American engines have laboured from the outset under one most serious disadvantage, wholly apart from that attaching to the insular prejudice of drivers and foremen. And this consists in the fact that they are not the sort of engines that American engineers or builders would have designed for the class of work they are put to. I do not wish to be misunderstood. I am casting no reflections on either British or American designers. I simply say that they view the requirements of traffic from different standpoints, and that a British engineer, keeping in mind the precise local requirements of British goods traffic and the special features of British methods and materials of construction, would design for a given class of duty an engine totally different from the one which an American engineer, bearing in mind the precise local requirements of *American* freight traffic and the special features of *American* methods and materials of construction, would design under the like conditions. No one who knows anything of American ways will contend that, had every point excepting the extreme dimensions been left to the Baldwin and Schenectady companies respectively, those builders would have constructed for the specific duty the same type of locomotive as that which they turned out to the order of the British railway companies. As it was, they had to do the best they could under stringent conditions.

While the highest official authorities still prefer to maintain reticence as to the relative performances of the American engines, it has been possible to glean a good deal elsewhere as to their working. After collating much independent information, I gather that they do their work well and satisfactorily, except that they burn more coal than the British locomotives employed on similar work. The question of repairs is still in the future, but as to the matter of coal consumption there is, I think, little doubt that that of the American engines is somewhat higher than that of the British machine. And the excess, if it really do exist, may very probably be attributable in a large measure, if not wholly, to the fact touched upon just now, that these engines do not represent the matured result of American experiences as applied to this particular type of locomotive designing. I may at once say frankly that even were the details of coal consumption

accessible they would not impress or even interest me. The experience of that memorable discussion, or rather dispute, before the Institute of Civil Engineers at the conference of 1899, constituted an amusing object-lesson as to the value of coal-consumption returns even when presented by some of the most eminent living mechanical engineers. The discrepancies were so hopelessly irreconcilable as to amount virtually to absolute contradictions.

So far the only definite report upon the working of the American goods engines in England that to my knowledge has been published is a brief memorandum from Mr. S. W. Johnson, chief mechanical engineer of the Midland Railway, furnished in response to an enquiry by the board of directors as to the result of the experiment of importation. In this memorandum Mr. Johnson says: "The whole of the forty engines purchased from America, namely thirty from the Baldwin Locomotive Works at Philadelphia, and ten from the Schenectady Works, are now working on the line, and so far they are doing their work in a satisfactory manner and taking the same loads as the engines built in this country. They are, however, heavier in the consumption of coal and oil than our own engines doing the same work."

On the other hand, a Midland driver (or foreman) writes in distinctly uncomplimentary terms about the American engines imported by that railway. He says: "It is evident the Midland locomotives from America are not worthy to be classed among the 'best' in that country, or their qualities of excellence would appear in this. As it is, the above engines are many years behind the times. One great fault lies in the bar-framing, which takes a good foot from the width of the fire-box, and, although a greater length is given, it doesn't counterbalance the evil. The lower tubes soon get choked with ashes in the smoke-box, while those at the top are too high to be acted on properly by the blast-pipe. Although they burn more coal than a 'Midland' engine, owing probably to the construction of the fire-box, as well as to the blast-pipe and tubes, in the sense above referred to, they are indifferent generators of steam. They require more oil than a Midland engine, and the 'needle' system of regulating it to the journals is vastly inferior to the old worsted trimmings, being, in fact, unsatisfactory from every point of view. A comparatively slight 'bump' against a Midland-built engine, whilst it produces no damage to the latter, doubles up the framing of the American—a case in point coming under my own observation only a fortnight ago. A driver is allowed 35 minutes to get a Midland-built engine ready for work—none too much—30 to put her away. It will take him—I speak as well of the

fireman—an hour to get the American ready, and fully 50 minutes to put her away at the end of his journey, and they have to work harder, too, to do it in the time. Altogether, they are veritable brutes, and a fireman, not to mention the driver, deserves at least a 50 per-cent. rise in wages." I quote these remarks without any comment, beyond the observation that my own experiences with American engines on other British railways were very different.

For, if the importation of American locomotives be a novelty in the Mother Country—barring the sporadic experiment of half-a-century or so ago—it is nothing new so far as most British colonies are concerned. I have had the advantage of personally studying the work of American engines in several of those colonies, but for my present purpose it will suffice to take the case of the one with which I have been most intimately connected, New Zealand, the most staunchly British of them all.

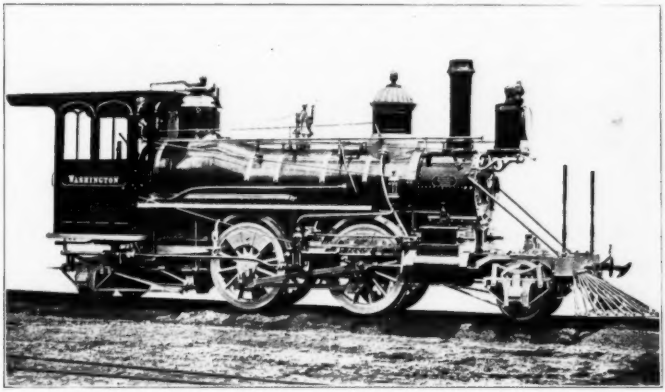
Early in the inception of New Zealand's State-Railway system it was found that none of the British types already in use fulfilled all the requirements of a main-line traffic on a track of 3 foot 6 inches gauge, mostly laid with iron rails weighing only 40 pounds to the yard. The most efficient types had been an English "Mogul" class ("J"); a six-wheel coupled class of saddle-tank engines ("F"); and Fairlie engines of the single-boiler type (class "R"). But it was desired to run expresses at an average speed of 30 to 35 miles an hour and to haul heavy freight of "mixed" trains up long 2 per-cent. grades with reverse curves of 500-feet radius. At that time two of my intimate friends, Mr. William Conyers and Mr. Allison Smith, were chief commissioner and locomotive superintendent respectively. I believe that both agreed in the advisableness of sending to America for engines of the type required. At any rate this was done so far back as the "seventies." The express passenger-engines were the first to arrive. They were locomotives strictly of the American type in all respects, save that instead of having a four-wheeled bogie at the leading end they had two two-wheeled Bissell bogies, or pony trucks, one leading and the other at the trailing end. I have never been able to discover that any advantage was gained by the departure from the normal American type, but it was persisted in even when six-coupled wheels were employed instead of four, as the loads became heavier—indeed, up to 1893, when the standard American "ten-wheeler" type with four-wheeled leading bogie was substituted. The earlier locomotives, Class "K," had cylinders 12 by 20 inches and 4-foot coupled wheels. They were eight in number and were supplied by the Rogers

Company of Paterson, New Jersey. The heavier engines which came out about the year 1880 were of the regular American "consolidation" class, with cylinders 15 by 18 inches, eight-coupled wheels, 3 feet in diameter, and a leading Bissell truck. They were built at the Baldwin Works, Philadelphia, and numbered six. Their class letter is "T."

Now these fourteen engines have been in regular work on the New Zealand State lines for more than twenty years, and I do not think that any capable and unprejudiced authority in the colony will contradict me when I say that they have proved from the first most efficient and satisfactory machines. The "K" class engines ran the Christchurch-Dunedin expresses for several years with entire satisfaction to everybody. The trains were not usually heavy, consisting ordinarily of six to eight long American bogie coaches—these being imported from the United States as well as the engines—nor was the timing fast, being at an average speed of about 30 miles an hour between stations, while a maximum of 36 was not supposed to be exceeded, though, as a matter of fact, speeds of 40 to 45 miles an hour were not uncommon when time lost by delays had to be made up, and I have several times personally recorded speeds of 48, 50, and 53 miles an hour with these engines. Once I noted a rate of 55 for a short distance, and even then the engine was not at all pressed. I do not doubt that 60 could have been reached had this been desirable. Also, the ascent by these engines of the long 2 per-cent. grades with sharp curves was very creditable, considering their small tractive force, only 60 pounds for every pound of effective pressure in the cylinders, and their low steam pressure, only 130 pounds per square inch. Thus the work done was distinctly good all round.

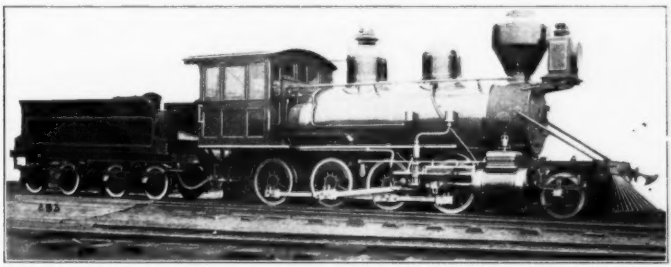
Nor were the "T" class "consolidation" engines at all behindhand in their different sphere. It was soon found that whereas the English "F" class with cylinders 10½ by 18 inches and 3-foot wheels six-coupled, could take only 13 loaded waggons up the 2 per-cent. banks, and the "R" class single-boiler Fairlies—which had cylinders 12¼ by 16 inches, and six-coupled wheels 3 feet in diameter—only 18, the American "consolidation" engines took 27 with certainty and comparative ease. This is not recorded as a triumph of American over English locomotives, for the great superiority of nominal power necessarily went a long way in accounting for the difference in work, but simply as noting the fact that the American engines proved a success and that their importation was justified by the result.

But in a few years the traffic had outgrown the capacity, not only of these engines, but of the railways themselves as well. The cheap-



EARLIEST AMERICAN EXPRESS ENGINE IMPORTED FOR NEW ZEALAND RAILWAYS.
Built at Rogers Locomotive Works, Paterson, N. J. Gauge 42 inches, cylinders 12 by 20 inches, coupled wheels 48 inches diameter. Class K.

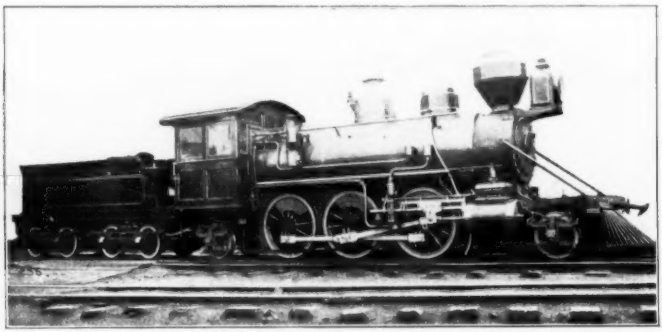
ness and slightness of the original construction of the roads soon proved a costly error, and as rapidly as possible the 40-pound iron rails were replaced all along the main lines with 53-pound steel rails. The "K" engines frequently had to run double on the expresses, and sometimes even one of the "consolidation" engines was put to this very unsuitable duty, which nevertheless it always fulfilled very well; but the plan of running an eight-coupled freight engine with 3-foot wheels at fairly fast speeds down falling grades was not to be com-



NEW ZEALAND RAILWAYS CONSOLIDATION LOCOMOTIVE.
Type of 1879. Cylinders 15 by 18 inches. Built at Baldwin Works.

mended. So designs were got out for twenty new engines, ten of which were virtually a great enlargement of the "K" type, with a third pair of 49-inch coupled wheels, placed between the other two pairs. The cylinder diameter was increased to 15 inches, and larger boilers with augmented steam pressure were provided. The leading and trail-

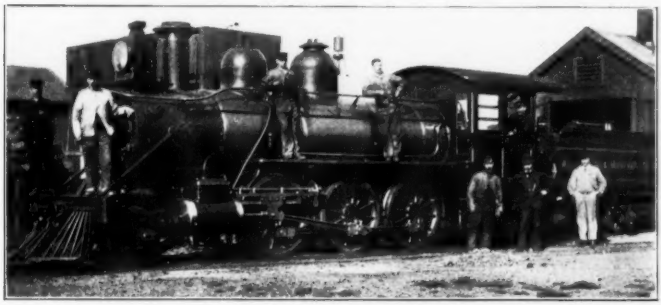
ing Bissell bogies were retained. The other ten engines were to be enlargements of the "T" or "consolidation" type, with cylinders 15 by 20 inches and 41-inch wheels six-coupled. By this time British patriotism had revolted against the idea of importing from America what could be made in Britain, so the order was sent to a leading British firm. The results were (1) that the Colony had to wait two years for full delivery of the locomotives; (2) that the first two delivered were found to be of excessive weight; (3) that protracted correspondence and negotiation and disputation took place, the outcome being, if I am correctly informed, that a mutuality of mistake was shown, and all twenty engines had to be altered in various ways to enable them to run over the New Zealand bridges. This, of course, meant terrible delay, and the need of more powerful engines had become urgent.



NEW ZEALAND RAILWAYS SIX-COUPLED LOCOMOTIVE, WITH FRONT AND REAR PONY TRUCKS. CYLINDERS 15 BY 20 INCHES.

So once more recourse was had to America, and, as before, with a wholly favourable result. Twelve engines were ordered by cable message—six of each class. They were supplied by Messrs. Burnham, Williams & Co., of the Baldwin Works, Philadelphia, and were delivered in New Zealand within five months of the date of the order being despatched, also at a cost of about £400 per engine less than that of those English-built. Moreover, so soon as they arrived they were put to their work and did it excellently. These were classed respectively "N" and "O." I should mention that the American "O" class have 36-inch wheels and 18-inch piston stroke, not 41-inch and 20-inch respectively, like those ordered from Britain.

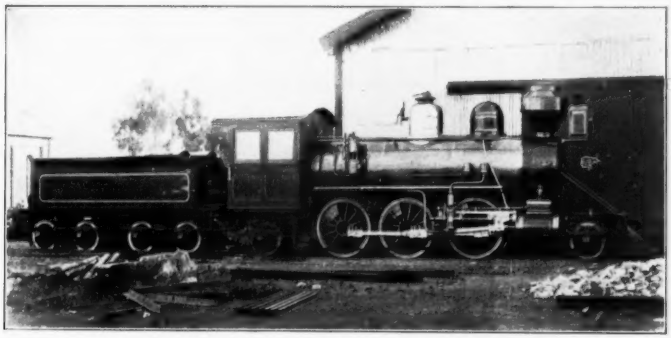
The class "N" engines have been employed for fourteen years, mostly in working the Christchurch-Dunedin expresses between the former city and Oamaru, a distance of 153 miles, and are the only



EXPRESS ENGINE BUILT FOR WELLINGTON & MANAWATU RAILWAY, NEW ZEALAND, BY THE BALDWIN WORKS.

This locomotive made the record run for 42-inch gauge—64.2 miles an hour, in 1892. It has cylinders 15 by 20 inches and six-coupled wheels 49 inches in diameter. Class N.

engines either given a schedule speed of 30 miles an hour or authorised to attain a maximum of 36, since their smaller predecessors of class "K" were relegated to inferior duty. Testing them twice for speed, I obtained rates of 58.5 and 59.2 miles an hour respectively, for short distances down falling gradients with loads of about 100 tons behind the tender. It must be remembered that this was on a 42-inch gauge and with 49-inch wheels six-coupled. At that time the speed was, I believe, an unquestionable "record" in such circumstances. Their haulage power also was very noteworthy. On one occasion under my own observation, when an engine of this type was "working back" in the ordinary course, it took without the least difficulty no fewer than 81 waggons loaded with wheat, a very solid class of freight, and with



STANDARD EXPRESS ENGINE, NEW ZEALAND STATE RAILWAYS BUILT AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

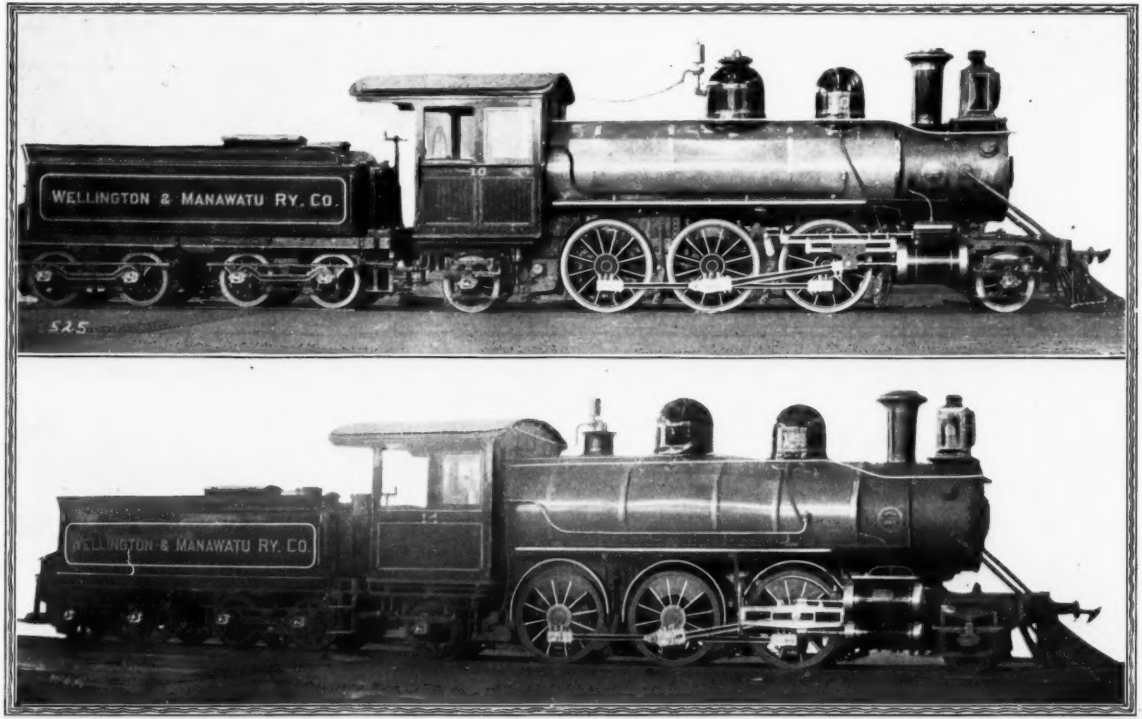
42-inch gauge, 49-inch coupled wheels; cylinders 15 by 20 inches. Class N.

this load ran at 25 miles an hour on the level. The "consolidation" locomotives of the "O" class proved even more useful than class "T."

About nine years ago the Wellington and Manawatu Railway Company, which, although a privately-owned line, covers the first 84 miles from Wellington, the Capital, of the (still unfinished) Main Trunk Railway through the North Island of New Zealand—intended ultimately to extend from Wellington to Auckland—and which up to that date had used only British locomotives, requiring some more, took warning from the experience of the New Zealand State Railways and sent the order direct to the Baldwin Works, Philadelphia. The engines ordered were of two classes; one was an improved edition of the class "N"; the other engines were of the "consolidation" order, but had 42-inch eight-coupled wheels and cylinders 16½ by 20 inches. Both have done splendid work. One of the large "consolidation" class took a load of eighteen American bogie cars on the level at 36 miles an hour, and one of the six-coupled "N" class broke all past records of the 42-inch gauge and established a new one by taking a light special train from Wellington to Longburn in 2 hours 2 minutes traveling time, and ran from Otaki to Longburn, a distance of 37.2 miles on easy grades, in 46 minutes 4 seconds, with an intermediate slack for relays and another over a bridge, or at an average speed of 48.5 miles an hour start to stop. If the delay through the two slacks be taken into account the start-to-stop speed was just 50.8 miles an hour. For sixteen consecutive miles a speed of 60 miles an hour or upward was maintained and a maximum of 64.2 was reached during a single mile, the engine running with entire ease and smoothness. I travelled on the footplate and made minute observations throughout the entire journey.

More recently the same railway company has imported several Vauclain compounds, built by the Baldwin company, and I hear good accounts of them. But the point is that since that railway first tried the experiment of procuring locomotives from America, none have been obtained elsewhere by the directors of that company. The fact is in itself suggestive.

Similarly on the State Railway of the colony, when more engines were needed recently, as the New Zealand workshops, which had turned out a number of most creditable and useful locomotives, proved unable to keep up a sufficient supply, America was again resorted to. It is true that under the influence of the patriotic wave which swept over the British Empire in 1897 in relation to the Queen's "Diamond Jubilee," an attempt was first made to obtain some engines in Britain.



ENGINES FOR THE WELLINGTON & MANAWATU RAILWAY, NEW ZEALAND. BUILT AT THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA., U. S. A.

The upper picture shows the six-coupled engine with pony truck front and rear, first run in 1891; the lower is the compound six-coupled with pony truck first run in 1894. Diameter of high-pressure cylinder, 10 inches; of low-pressure, 17 inches. Stroke, 20 inches.

NARROW-GAUGE LOCOMOTIVES BUILT FOR THE CAPE GOVERNMENT RAILWAYS, SOUTH AFRICA. BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y., U. S. A.

Both are 42-inch gauge; the 10-wheel engine above has 54-inch drivers, 11 feet 4 inches rigid wheel base, 17½ by 26 inch cylinders, weighs 107,830 lb., of which 85,350 lb. is on the drivers, and carries 180 lb. steam pressure. The consolidation freight locomotive below has 48-inch drivers, 14½ feet rigid wheel base, 18½ by 24 inch cylinders, weighs 115,450 lb., of which 101,670 lb. is on the drivers, and carries 180 lb. steam pressure. Built in 1900.

But the experience proved an exact counterpart of that which brought about the orders given by the three British railway companies last year. All the manufacturers were so full of orders that they could hold out no hope of a reasonably early delivery, with the single exception of Messrs. Sharp, Steward & Co., who undertook to supply a few. So again New Zealand went to America and ordered from Messrs. Burnham, Williams & Co. (1) ten express engines of the American "ten-wheeler" type; (2) twelve ten-wheeled tank-engines with leading and trailing Bissell trucks. Thus the total number of American engines at work on the New Zealand railways up to the latest date of my advices was fifty-two, and I believe I am warranted in saying that the experience of their performance in regular practice has been almost uniformly favourable. In my own association with them I found that many British drivers who at first despised and disparaged the American engines as mere "Yankee notions" soon grew to appreciate their efficiency and hardiness, while some higher officials—one of whom characterised the first American locomotive imported as "a braying abortion," came to learn that it was possible for a good engine to be built outside Britain, a lesson not easily inculcated or assimilated when a genuine John Bull is the pupil.

I had written so far when I received a reply from Mr. Allison Smith to my enquiry as to his personal experience with American locomotives on British colonial railways, notably those of New Zealand and Victoria, while he held office as chief mechanical engineer in each case. "My own experiences," said Mr. Allison Smith, "were entirely satisfactory. The sole drawback originally attaching to American engines was that their bogie and tender wheels were made of chilled cast iron. These, of course, could be easily replaced in America when necessary, but not so in the colonies. Therefore we substituted for them ordinary waggon wheels, which we put on the same axles. But otherwise the American locomotives gave us complete satisfaction. It is true that at the outset an attempt was made in Australia by certain persons, no doubt in the interests of local manufacturers, to get the American engines condemned as inefficient, but I found that the locomotives had been tampered with, or at least had undergone undesirable alterations which impaired their steaming power. Directly I rectified these things they steamed splendidly and did their work to admiration. Indeed, so much better are American engines suited than British engines to colonial railways, with their rough and lighter roads, that in my opinion no others ought to be used on those lines."

I cannot do better than to leave the matter at so satisfactory a point.

ENGINEERING OPPORTUNITIES IN CENTRAL AND SOUTHWESTERN ASIA.

By Alexander Hume Ford.

Mr. Ford's preceding article, in our February issue, dealt with Russia's schemes for internal development by the perfection of means of transport and communication, already largely crystallized into definite systems. In the present paper he advances to the farther-outlying portions of the Tzar's growing empire—to regions teeming with new influx of life, seething with new activity, clamorous with demand for the means and the machinery wherewith to work up their rich resources, but so many-voiced that their needs can hardly yet be classified and orderly arranged. And in this harvest of opportunity, too vast for any one band of workers to gather, he urges the great industrial nations to work in harmony and co-operation.—THE EDITORS.

WITH Russia pushing the industrial development of her Black Sea and Central Asian districts so vigorously that she cannot begin to supply the number of engineers or the material needs for the carrying out of her stupendous projects, it is lamentable that the exporting manufacturers of the great Anglo-Saxon nations should maintain separate and antagonistic trade organizations and combinations in this part of the world, seeking to interfere with each other, instead of realizing that their interests are identical and demand hearty co-operation.

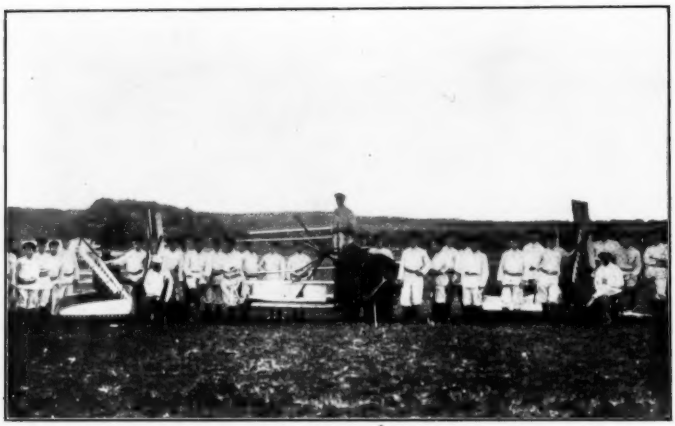
In parts of European Russia there is an annual increase of 30 per cent. in the number of factories and machine shops erected, some of them equipped with the most modern and powerful machinery in the world; in Trans-Caucasus, the hand loom is being replaced by the cotton mill, worked by steam or water power; the three thousand miles of the Trans-Caspain Railway, although built solely as a military road, have been of necessity turned over to the Department of Commerce, owing to the unexpected and enormous increase in traffic along the line; not merely this, but so rapid has been the unlooked-for development and settlement of central Asia by European Russians that it is now deemed necessary that three additional railways should be built to connect the Trans-Caspian system with that of European Russia. One of the projected roads is to descend from Orenburg in the Urals,

another from a point not far distant from Astrakan, while the third (and the most important to America), is being constructed across the Caucasus Mountains, with the aid of capital secured in Wall Street, and in time will be continued on to Teheran.

A PRIMITIVE HOME OF NOMADIC TRIBESMEN IN CENTRAL ASIA.

The building of this railroad is certainly the most difficult piece of engineering yet undertaken by Russian engineers, although possibly men who surveyed and built the Canadian Pacific and other railroads through the Rocky Mountains might look leniently upon the engineering difficulties encountered between Vladikavkas in the clouds and Petrovsk on the shores of the Caspian Sea, and thence to Baku. This road has just been all but completed, and now connects all Russia with the ferry across the Caspian plying between Baku, its present terminus, and Krasnovosk, the starting point of the Trans-Caspian Railway. The Petrovsk road passes through many gorges where swollen mountain streams sweep down, carrying away bridges and wrecking miles of track, and as the railroad is the only connecting link between the cotton mills of Moscow and the plantations of Central Asia, which supply the raw material, the importance of uninterrupted communication cannot be overestimated.

With the completion of this through rail and steamship line from Russia's capital to western China and to Herat in Afghanistan, the peopling of central Asia with Little Russians is progressing with renewed energy, and Russia is brought within hailing distance of her long-coveted port on the Persian Gulf, insuring the carrying out of the stupendous engineering projects outlined for the advancement of the Tzar's Empire to convert central Asia into a granary and store-



A CLASS IN MODERN AGRICULTURAL METHODS AND THE USE OF MACHINERY.

house of supplies. Already an American syndicate, at the invitation of the Tzar, has sent over its engineers and experts to report upon the possibilities of converting a vast desert into a well irrigated and richly producing area. If the report is favorable, the syndicate is to invest $70,000,000 in the construction of canals and irrigation works, in return for which it receives rent free for many years a large tract of land, besides many other valuable concessions.

Until Central Asia is adequately opened up by the completion of the proposed Persian Gulf railroad, all foreign equipment for her growing industries must enter the Russian Empire through Black Sea ports. In fact, trade impetus has long been felt in this region. Great caravans no longer cross the Pamirs from India. Tea and other products are sent from Bombay by steamer to Batum, and thence overland by rail and boat to central Asia, benefiting both the railroad revenues of Russia and the shipping interests of Great Britain.

So important is the Black Sea as a commercial highway that some time ago an American line of steamships was put on between New York and Odessa; but notwithstanding the fact that the freight was carried in British bottoms, a fight was made on the new line, and as the war with Africa sent charter rates ever upward, for a time shippers of machinery and rails were compelled to ship via Liverpool and Hamburg, as before. But Russia seems determined to have an American line, and the recent ukase forbidding any foreign vessel to stop at more than one Russian port will help rather than hinder American possibilities in the Black Sea.

It is from this district that the energetic business-seeking Hebrews of Russian birth have come to New York. Some have become American citizens, others have remained Russian subjects; and as 51 per cent. of the stock of all Russian steamship companies, as well as that of certain other industrial concerns, must be owned by Russians, the aid of the Russo-American has already proved invaluable to the business interests of the United States.

As the building of the Trans-Siberian Railway has compelled the present construction in America of the largest freight-carrying steamships in the world, besides giving an impetus to American industries and investment in northern Asia not dreamed of a decade ago, so history is repeating itself in the south-western part of the continent. In Manchuria and Siberia, American and English machinery drove out all competition in short order, and should the interests of these two nations consolidate in the near East, the same result would inevitably follow there. Already Belgian structural metal is giving way to American. Germany imports machinery from the United States to Hamburg and exports it again to the Black Sea ports as her own.

German manufacturers and investors, realizing that they place themselves at a manifest disadvantage in attempting to compete with the industrial output of both Anglo-Saxon countries on an equal footing, while not giving up the fight in Russia, have turned to Turkey, buying up her railway system, so that none but German material will

THE "NEW ERA" MACHINE GRADING THE LINE OF THE SIBERIAN RAILWAY.

hereafter be used in building extensions, and only German goods will be carried over the lines at fair rates.

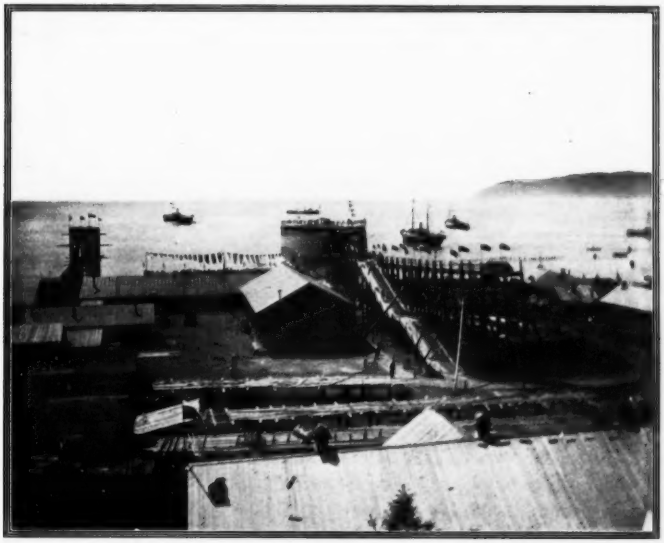
In fact, everything demonstrates that in the near East is needed a vigorous application of the Anglo-American open-door policy. At present Russia would doubtless lend her aid in forcing the issue, for Germany has ruthlessly entered like a wedge between French and Russian interests in Asia Minor, forcing Russia back upon the Black Sea coast, along which she has projected her railroad in Turkey, while from Trebizond southward a main line will run down through Armenia and Persia. It is at Trebizond that American ships will probably be called upon to land their cargoes of rails, locomotives, and track-laying tools needed for these new Russo-Asiatic railroads.

England's sphere lies still further south, beyond that of France. Awakening at last to her imminent danger of being entirely shut out of southwestern Asia, the project of a British railway from the Holy Land to Bagdad, possibly continuing on to India, has been revived; so that there now seems a possibility of the Cairo-Calcutta Railroad be-

MECHANICAL EXCAVATOR WORKING ON RUSSIA'S CENTRAL ASIAN WATERWAYS.

ing built. It is even suggested by the United States consul at Constantinople that American capitalists should construct a railroad southward from one of the Black Sea ports, through the richest agricultural districts of Turkey, which are also the center of American missionary effort.

Certain it is that the near East is being awakened from her long slumber. On the Black Sea new ports are being constructed, harbors deepened, and many improvements made in which Anglo-American machinery and engineering plays no small part. More than ever Rus-



LAUNCHING THE ICE BREAKER AND TRAIN FERRY ON LAKE BAIKAL.
The boat is built after the model of the car-ferries on the American Great Lakes.

sia feels the need of her projected Black-Caspian Sea ship canal. which would make Krasnovodsk an important seaport. In fact, with the harbors of the Caspian being deepened with British-built American dredges, the most complete and largest in the world, it is not surprising that Anglo-American capital seeks investment in the oil wells and other industries about the shores of this great inland ocean, which is rapidly becoming more and more familiar to our western engineering experts.

Now that the great beyond, central Asia, once the teeming center of earth's greatest multitudes, is at last opened to the inspection of the world and outside aid courted to make it again the center of the world's commerce and industries, the Anglo-Saxon will not be slow to enter.

More than ten million peaceful workers now inhabit this region. Along the line of railroad Russian cities of 30,000 inhabitants have sprung up, while trains leave Krasnovodsk daily, laden with emi-

A HAND LOOM IN THE CAUCASUS.

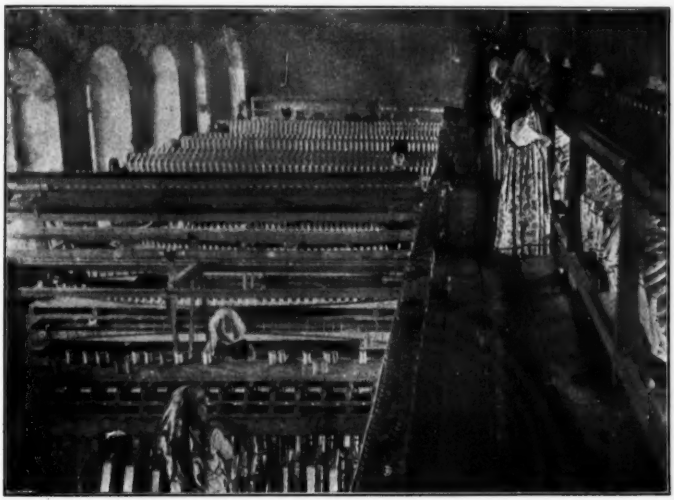
The type of appliance which is giving way to modern mechanical apparatus.

grants, machinery, and mixed freight. Everywhere along the line of road are encountered mechanical problems which can be successfully solved by the brain of the inventive engineer alone. At Krasnovodsk the fresh-water supply is distilled from the Caspian. Tanks carry it for hundreds of miles inland to Kazil Arvit, where the repair shops of the railway are located. The immense steam hammers and excellent tools of these extensive shops were supplied by German factories a dozen years ago, yet the plant is still capable of turning out complete modern locomotives. The government, however, finds it more economical to import from America.

The country about abounds in iron, copper, and sulphur mines; oil is also found, the refuse of which is used as fuel. With the new life throbbing through the country, smelters, forges, and many new kinds of machinery will be needed, much of which must necessarily be of a type which Russia cannot hope to manufacture at present. In fact, it will be many years yet before Russia can begin to supply her own needs in central Asia. Small factories are springing up everywhere beyond the Caspian, so that hand labor is decreasing, while new demands for mechanical appliances occur continually. Farmers and merchants combine to purchase machinery on the co-operative plan; private individuals spend large sums establishing new industries, and are invariably rewarded by the government. Trees, cotton plants, grape vines, and many kinds of seeds are imported. Cotton culture, for instance, has grown from the insignificant beginning of a few

years ago to such proportions that Russia now considers herself independent of Egypt and America. Primitive cotton presses must soon give way to the powerful steam moguls used in the southern States. Bagging factories must make their appearance, and to compete on an equal footing with other nations for the cotton-goods market of Asia, doubtless the experiment of building great cotton factories in central Asia will be tried. The time-worn Russian policy of admitting duty free such mechanical appliances as her people may need to develop infant industries is already resorted to, but whatever industries are started are nevertheless assured ample tariff protection.

Owing to the fact that until very recently all central Asia has been under absolute military control, no one being allowed to travel on the Trans-Caspian Railway without a permit from the war department, foreigners have had little or no opportunity to investigate its possibilities for investment. That there are opportunities for Anglo-American enterprise there now remains no doubt. It is still impossible, during wind storms at night, for the trains to run over certain portions of the road, as the sand of the desert is piled up in billows across the tracks. So far, Russian engineers have found no means of successfully combatting the sand. Again, in the building of dams for irrigation, they have left much to be desired, and the perfection of the canal system of central Asia is the paramount necessity of the country.



A BEGINNING IN THE USE OF POWER IN THE SILK INDUSTRY.

Merv, a city miles in extent, now destitute of a living soul, was ruined in a night by having its aqueduct cut by the enemy. The Murghab, however, is again being deflected into its ancient lateral waterways, immediately demonstrating the truth of the boast of the ancients that there is no spot in the world more productive than this oasis.

The Russian Government has very wisely left the matter of contracting for irrigation works in the hands of the various tribes and communes. The headsmen make their contracts for engineering works, then put the entire colony at work, dredging ditches and carrying out the orders of the engineer. Primitive methods are giving way to the improved systems introduced into India and America by the Anglo-Saxon.

Under irrigation, former desert lands yield 26 tons of grapes to the acre, and so superior are they that thousands of tons are annually transported by rail into Russia. Irrigation is redeeming vast areas, and it alone makes necessary the building of the various lines projected across the desert between European Russia and Turkestan, which latter country is already well settled with Russian peasants assisted by the government. At the base of the Afghan mountains the supply of water is plentiful. Rivers as great in volume as the Missouri flow down from the hills; steamboats ply the streams along

A RUINED FORT AT MERV, TURKESTAN.

SUMMER HOME OF NOMAD TARTARS NEAR EKATERINENBURG, URAL MOUNTAINS.

The booth is made of skins stretched over a wooden framework. Inside of this house was found—a Singer sewing machine. Photo by E. O. Hovey, Esq.

the Afghan border, carrying Russian tradesmen and commerce toward India. In fact, the great crying need of central Asia is a shipyard on the banks of the Amu Daria for constructing river steamers. So great is the volume of this river and the amount of deposit carried down that the level of the Aral sea is rapidly rising, so that its waters may yet in time overflow its banks, seeking an outlet in the bed of the ancient gulf connecting the Aral Sea with the Caspian; or the engineers may decide to construct a canal between the two seas, instead of turning the course of the Amu Daria at Tcharjin, as it is now proposed to do. If either of these projects is ever accomplished, and steamers can ply from the Volga to the edge of India, the economical balance of Europe will be overturned. At present, owing to the enormous cost of trans-shipment of goods on both sides of the Caspian, it is still possible during certain seasons, in spite of a seemingly prohibitive tariff, for American cotton to compete with the central Asian product. Should the canalways and rivers of Europe be made tributary to this new cotton-growing region, Russia could undersell American cotton in the markets of Europe as frequently as she does American wheat in the Trans-Atlantic grain exchanges, to say nothing of tobacco and other products of American seed she is introducing in her new Asiatic garden, which may spread over a million square miles in area, destined soon to be intersected by many rail and waterways.

However, many years must pass before Russia can hope to compete in manufactured articles, machinery, etc., with the older nations, and in the meantime it should indeed be a golden age of profit to those best able to supply the material for the development of every kind Russia is bringing about over an area of 8,000,000 square miles, affecting over 130,000,000 people, whose wants are increasing year by year as an autocratic government forces education upon them; for Russia is at last most certainly making a real and earnest endeavor to uplift her illiterate masses.

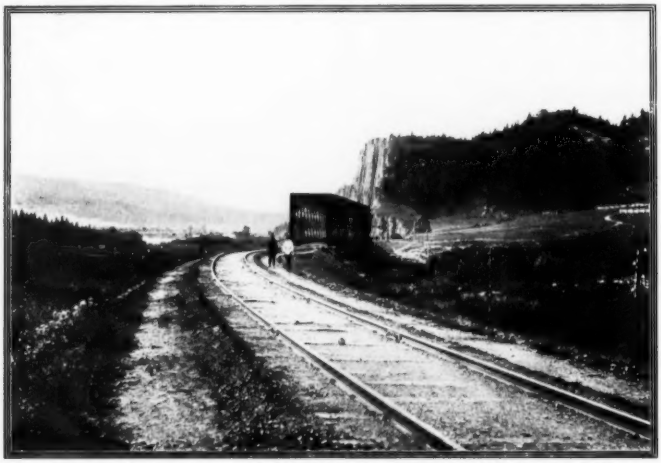
The throwing open to the world of the Trans-Caspian road is but a forewarning that a general breaking down of barriers is to take place. Russia seems about to emerge from her semi-seclusiveness, to take her place among the industrial nations of the world. As a sign of the times, she has repeatedly invited England to meet her half way in the extension of railways into Afghanistan. Russia is quite willing to undertake the "pacification" of the Ameer and to overcome his objections. It is true that the advantages accruing to Russia, should she ever secure through rail connection with India, would be of inestimable value; but that it is eventually inevitable that the connection will be made seems most certain to impartial observers. The consensus of opinion, even in England, is that it would be well for Great Britain to make the best terms possible with Russia while she may; for under certain enforced treaty regulations, a through line from Calais to Calcutta might be made of equal commercial importance to both England and Russia. When it is taken into consideration that mail sent from London to Shanghai via the Trans-Siberian Railway, even before that road is completed, reaches its destination far in advance of matter sent by water, the possibilities of rapid train service carrying important dispatches through to India in seven days is readily seen. With the completion of but four hundred miles of railroad through the valleys of Afghanistan, perishable freight could be forwarded from Great Britain to her oriental colony, and *vice versa*. Business men could make the trip between the two countries within the week. India and England would be drawn many days nearer each other. Russia's advantages would certainly be great, it is true, and to secure them she would be willing to grant many concessions. It is very probable that in exchange for permission to make the desired rail connection with the Indian system, Russia would lift from English through goods the embargo of extortionate rates now exacted on all foreign merchandise going into or through central Asia. It is too much to expect that the request for an open door in central Asia would receive any favorable

DEMIDOFF IRON MINES, TAGUIL, URAL MOUNTAINS.
Showing the method of taking out the ore (magnetite) by benches.
Photo by E. O. Hovey, Esq.

TARTAR MINERS IN THE GOLD PLACER MINES AT MIASK, URALS.
By courtesy of E. O. Hovey, Esq.

response, but although Russia is already pushing her railways through Persia to the gulf, it is not too late to save that country almost intact for the now world-announced Anglo-American policy.

In northern Persia, Russian sway is absolute. Splendid roads, built by the Tzar's order, abound; bicycling there and in central Asia is a common sport. Russia's wand of progress is touching the land; misery, poverty, and slavery pass away, to make way for enterprise and prosperity. The credit of this can no longer be held back from Russia. Wherever her iron rails have gone, cities regularly laid out have sprung up, perfect sanitation and fine buildings are the rule,



ON THE LINE OF THE SIBERIAN RAILWAY. AN AMERICAN-BUILT BRIDGE.

Photo by Prof. S. W. Beyer.

sturdy settlers bring new life into the country, and all is activity. Restless energy is to-day at work everywhere in central Asia; all that is lacking is perfect means of communication with, and transportation to and from, the outer world.

It would seem that no nation has a right to demand in Asia an open-door policy, and at the same time seek to throttle the very life of its most energetic child. Under the new conditions beginning to exist, the Slav must find his way to the Indian Ocean. By the natural order of things, Russia must soon break through. Her surplus population increasing at the rate of two million annually must find new homes in less crowded portions of the Empire. One hundred and thirty million people press down upon southwestern Asia, and the strain is continu-

A TARTAR VILLAGE OF MINERS, WONLIARLIARSKY COMPANY'S MINES, NEAR TSCHELIABINSK, SIBERIA.
By courtesy of E. O. Hovey, Esq.

ous as the overflow is eternal. Once Russian rails are laid to the two Persian Gulf ports the Tzar has acquired from the Shah, now little more than his vassal, great cities and vast enterprises must inevitably spring up. Bombay and Calcutta will have rivals, it is true, but rivals that will increase their trade; for through these gateways of commerce for years to come must pour the material needed for the exploitation of the new Empire. Until from these prospective gulf cities Russia can dispatch her merchant marine fleets to all parts of the world, England and America will not only be called upon to build more war-ships and merchant vessels for the Muscovite, but with Persian ports almost in the track of British oriental trade, and halfway between the Atlantic and Pacific ports of the United States, all Anglo-Saxondom must inevitably share in the prosperity and development of central and southwestern Asia. Germany alone is capable of proving a rival; and as America is now becoming a nation with a vast surplus of wealth seeking profitable investment abroad, it would seem well for England and America to work hand-in-hand with Russia for the development of the Asiatic domain of the Tzar, but at the same time to insist on an open-door policy for all time in any new territory they acquiesce in permitting Russia to dominate, thus assuring the manufacturers, inventors, and engineers of future generations the possibility of room for the vigorous expansion of their genius and ability.

COST DETERMINATION IN ISOLATED ELECTRIC PLANTS.

By Percival Robert Moses.

In every department of mechanical production, the foundation of safety and success is an accurate knowledge of costs. Mr. Moses considers this study in a comparatively new field—the small but varied individual power plant—from which valuable lessons of wide importance may be learned.—THE EDITORS.

A NUMBER of interesting articles have appeared from time to time in THE ENGINEERING MAGAZINE on the subject of cost keeping and cost finding in manufacturing plants, and the vital necessity of such systems has been universally recognized. The lack of a similar system in the operation of individual electric plants in buildings is a serious drawback when the question of designing new plants or improving old ones is laid before an engineer or architect; and it accounts in great measure for the small improvement to be seen in the apparatus and methods employed in these plants.

The question may be: "Shall we use hydraulic or electric elevators?" or, "Is electricity cheaper from a central station at so-and-so much per kilowatt hour, than it would be from our own plant?" or, "What will it cost to use water-tube in place of horizontal-tubular boilers?" Each consulting engineer has, presumably, collected more or less accurate data on various questions, which enable him to design the plants he installs; but the owner who pays the cost of running, seldom knows, after the plant is installed, the cost of separate items. Frequently a change in methods or apparatus is proposed, and he finds that he has no means of settling the question of its advisability. In order that waste may be avoided, that the plant may be kept up-to-date, and that carelessness may be checked, some system must be employed by which the cost of the various items making up the total may be determined. A few of the features of a system, which I have adopted in several large buildings in New York may be helpful to others wandering in the same fog of difficulties.

The chief object of the system, originally, was to fix the cost per kilowatt hour of electricity in various types of buildings, in which private plants were in operation, and at another time I hope to give some of the results derived from the records kept. The original scope broadened of necessity, as fixing the cost of one item depends on determining the cost of the others. Cost keeping, as it applies to buildings,

has two objects: to raise the standard of production, and to lower its cost. To obtain the first object, it is necessary to know the results; and to attain the second, it is equally necessary that the cost shall be known.

To get this knowledge of results and costs, a system of "log" records, similar to those used on shipboard, will give satisfactory results, provided the figures are accurately noted and the results studied with intelligence. This log sheet, on which entries should be made at least hourly, serves the double purpose of showing the variation in the amounts of water used, current supplied, or coal fired, and of causing continual inspection of the plant and its operation. In addition to the hourly entries, the sheet should contain spaces in which can be entered the total amounts of raw material used, *i. e.*, coal, water, oil, etc.; the amounts of electricity, refrigeration, etc., or product manufactured and supplied, as determined by recording and integrating meters or by calculation. Record should also be kept of repairs, troubles of any kind, complaints, time spent in making repairs or changes, times of arrival and departure of employees, and the hours of operation of different pieces of apparatus.

On page 1085 is shown a blank used in an office-building plant containing a storage battery. The first columns show time of readings, number of gauges of water held in the different boilers, boiler and back pressures, temperature of feed water, coal used, and electricity delivered for lighting and for power. Reading these figures takes less than five minutes out of each hour, and insures an inspection of the plant twelve times a day.

The coal used is not measured hourly, although, for purposes of determining the effect of different kinds of load, the amount used per hour can be closely approximated. Instead, in this plant (which is a small one) a hopper holding from one-eighth to one-sixth of a day's supply is filled from a bin and emptied by dumping in front of the boilers. The time of filling, and the number of hoppers, are marked by the fireman, and the weight of coal figured from this. This is not as accurate as weighing, but tallies closely with the amount of coal delivered. In another plant the coal had to be wheeled into the fireroom, and a scale was sunk in the passage way. These methods are mentioned to show that the recording of results is a simple matter and does not involve expensive installation or use of time.

On the lower left-hand corner of the blank is the time sheet, on which times of arrival, departure, and total hours of working are noted, as well as the hours during which each important piece of apparatus is in use. Log blanks similar to this are found in several of

the building plants, but they are of little practical value for determining the cost of operation and amount of product, on account of inaccurate readings and careless entries. Their chief value is to insure constant inspection and to give a record of the hourly variation of product, which, in this particular building, is electricity.

To determine the cost and check the records, the usual log blank has been added to, and in the central space are columns in which are entered the totals shown by the recording and integrating meters, or obtained by other means, and the cost of the material and labor used in the manufacture of the plant product. The remainder of the sheet is used for notes as to repairs, complaints, accidents, or suggestions.

In hotels, apartment houses, or similar establishments, where refrigeration is supplied, blanks are used with additional columns for hourly readings of temperatures of incoming and outgoing brine and condensing water, head and back pressures of ammonia, brine, and water circulated. The readings upon the water serve as checks on wastefulness either of the machine or the attendants.

With the same object, indicator cards should be taken of the engines, about once a week at different periods of the day. To determine the cost, continuously recording instruments are necessary, and it is gratifying that the importance of these is becoming more widely recognized, and all large plants are equipped with them to a greater or less degree. When the installation includes boilers, electric elevators, electric lights and motors, refrigerating and laundry machinery, as in a modern hotel plant, the instruments required for intelligent supervision of the plant operation would be: a clock, separate water meters to measure water supplied to boilers, refrigerating machine, condenser, and house service (although the water supplied to the condenser will be used for both other services); recording steam-pressure gauge for high pressure; separate integrating watt meters for light, electric elevators, and large motors; ammeters and voltmeters to measure electric output; brine meter for circulating brine; thermometers for feed water, condenser water, incoming and outgoing brine, hot-water tanks, and engine and boiler rooms; ammonia high and low-pressure gauges; brine pressure gauge.

In small plants many of these instruments may be omitted, but in large plants they are a good investment and not a luxury. With the records of these instruments and a few constants determined once, carefully, for the plant, the calculation each day of the number of units of raw material used and product supplied is comparatively simple and will not take up over a half-hour of the chief engineer's time.

BUILDING. DATE.

TIME.	WATER GAUGES. 1	2	3	4	PRESSURES. BOIL.	BACK.	TEMP. F. W.	COAL.	AMPERES LIGHT.	POWER.
6.00 A. M.	3	3	....	....	30	0	30	.....	0	0
7.00 "	2½	2½	....	....	90	5	110	.....	30	.....
8.00 "	"	"	....	....	"	"	140	.....	300	.....
9.00 "	"	"	....	....	"	"	170	.....	500	.....
10.00 "	"	"	....	....	"	"	190	.....	500	.....
11.00 "	"	"	....	....	"	"	"	.....	500	.....
12.00 M.	"	"	....	....	"	"	"	.....	300	.....
1.00 P. M.	"	"	....	....	"	"	"	.....	500	.....
2.00 "	"	"	....	....	"	"	"	.....	500	.....
3.00 "	"	"	....	....	"	"	"	.....	500	.....
4.00 "	"	"	....	....	"	"	"	.....	500	.....
5.00 "	"	"	....	....	"	"	"	.....	500	.....
6.00 "	"	"	....	....	"	"	"	.....	500	.....
7.00 "	"	"	....	....	"	"	"	.....	150	.....
8.00 "	"	"	....	....	"	"	"	.....	100	.....
9.00 "	"	"	....	....	"	"	"	.....	75	.....
10.00 "	3	3	....	....	30	3	"	.....	50	.....
Totals..	....	....	....	....	.....	.....	.....	.....	5,505	.....

MISCELLANEOUS.

CURRENT.	PRES. READ.	PREV. READ.	DIFF	RATE.	COST.
Edison—Power	4,710,700	4,710,600	100	.....	.....
Edison—Light	.....	.....	...	.....	.....
Gas.....	.....	.....	...	.....	.....
Water.....	291,190	290,240	950	.10 per 100 ft.	.95
		QUANTITY.			
Coal.....		16,395 lbs.		.10 per 100 lbs.	16.39
Cylinder Oil.....		3 qts.		.10 per qt.	.30
Engine Oil.....		10 qts.		.07½ per qt.	.75
Carbons.....		25		2 8 each.	.70
Lamps.....		{ 1-16 c. p. / 1-32 c. p.		{ .17 each. / .20 each.	{ .17 / .20
Wages—Eng. and Fire..		.....		.....	15.82
Wages—El. Runners.....		.....		.....	.....
Overtime—Eng. and Fire.		.....		.....	.....
Overtime—El. Runners.		.....		.....	.....
				Total.....	$35.28

TIME SHEET.

EMPLOYEE.	ARRIVE.	DEPART.	TOTAL.	MACHINE.	START.	STOP.	TOTAL.
Engineer.....	7	6	11	Boiler No. 1.	6	10	16
Assist. Engineer.	7	6	11	" No. 2.	6	6	12
Night Engineer.	10	10	12	" No. 3.	.....	.....	.....
Fireman No. 1.	6	6	12	" No. 4.	.....	.....	.....
" No. 2.	6	6	12	Engine No. 1.	7	6.30	11½
" No. 3..	10	10	12	" No 2.	7	10	15
Oiler	7	7	12	" No. 3.	.....	.....	.....
El. Runner No. 1	.....	.....	... .	" No. 4.	.....	.....	.....
" " No. 2	.....	.....	.....	.....	.....	... ...	....
" " No. 3	.....	.....	... .	.....	.....	....	.....
" " No. 4	.....	.....	.....	.....	....	....	.....

		REMARKS.
Voltage.....	240	METER:
St. battery charge without discharge..	.....	2,991,000
		2,960,610
St. battery discharge without charge...	.....	30,390
Total K. W. hours of dynamos.....	1,519,500	5
Average temperature of day.....	44¾	151,950 K.W. hr.
Cans of ashes.....	30	(Signed) ..... Engineer.

1085

FORM OF LOG SHEET FOR OFFICE BUILDING, WITH STORAGE BATTERY.

Noting the number of pounds of coal, gallons of oil, or cubic feet of water, however, conveys but a hazy idea of the day-by-day operation of the plant, and for this reason the costs of material and labor for each day are figured up and recorded. The summary then shows at a glance excessive waste or trouble, and keeps the chief engineer keenly alive to the results obtained and the cost of carelessness.

The value of such definite figures has been shown and one instance may well be quoted: In a large building, pea coal had been used exclusively and cost, at the time the system was installed, $3 a ton delivered. A new method of fuel burning was proposed by which No. 3 buckwheat or rice coal at $2 a ton could be substituted. The plant engineer, called in by the owner, decided in the usual off-hand fashion that the change would not pay, for various reasons. The proposer of the plan persuaded the owner to a trial, stating, "You can measure the water delivered to your boilers and evaporated, and the coal used for a week, with the two kinds of coal; and if you don't save 20 per cent. I will remove the apparatus and replace the plant in its original condition, without charge." The proposition was accepted, and a saving of nearly $2,000 a year effected.

The records by themselves, with careful study, can and do lead to improvement in the operation of the plant and reduction in the cost, as has been shown. For the decision of questions of original design, and of relative value of different kinds of service, the probe must go deeper, and the costs of each product should be determined as closely as possible. Where the product is varied, exact results are not obtainable, but the error can be reduced to one of little consequence.

It is necessary to consider the nature of the work done in buildings, in order to reach a basis from which the cost may be deduced. In the climate of New York the product of a complete plant in a building may be roughly divided into water supply, heating, lighting, building supervision, elevator service, refrigeration, laundry and kitchen work. The simplest type is that of a five-story building, without an elevator, in which only the first four items are to be provided; and the most complicated instance is a hotel plant of six or more stories in which all the factors enter. These products may be supplied from a central service or from a private plant.

In the five-story building, the heat may be furnished by steam or hot water from an outside source; the lighting by a gas company; and the water by city pressure. In this case the cost of heating a hundred cubic feet could be easily determined from the bill for steam, and the cost of water and light, in a similar manner, from the water and gas

bills. If no steam service was available, a boiler would be installed and the cost of heat would be the cost of the coal, water for boiler purposes, repairs and supplies, labor of running boiler, and fixed charges. If no electric service was available, and a plant was installed and the exhaust steam used for heating, the cost of the heat would not be changed and the cost of electricity would be the difference between the total cost and the cost of heating and building supervision.

If the building was eight-storied, the simplest case would introduce two additional factors—elevator service and water supply. The basic cost is again the cost of heating, etc., by steam from an outside source or from a private plant, regardless of the source of supply of the power for water pumping, elevator service, or electricity. This power may be, and generally is, supplied from an outside electric source, and the cost of each factor is determined by the amount of power and the character of the load. The same holds true in regard to the service from a private plant; the cost of the three factors is the difference between the total cost and the cost of heating and supervision of the building. This difference in a building plant is made up of the costs of coal, oil, water, gas or electricity from a central station for night service, sundry supplies, repairs, labor, and fixed charges.

For ordinary purposes the items of coal, oil, water, and central service, may be divided up among the factors in proportion to the amount of power used by them, as shown by the recording wattmeters. The labor, sundry supplies, and repairs, cannot be so apportioned. Each product must be charged with the repairs, supplies, and special labor (such as ice handlers and electricians) pertaining to the apparatus it requires. If electricity is required at night, and no heating, all the expense for running at night must be charged to electricity.

The cost of general labor in excess of that required for heating, such as that of chief engineer, assistants, and firemen, depends for its division, in my opinion, on the purpose of the investigation. If the object is to determine the unit cost for each factor in a plant of similar character, the cost of general labor could be apportioned between the various factors in proportion to the power used in their production. Such a figure would have a limited value, as the usual purpose of an investigation of this character is to determine the relative value of differing types of engines, boilers, grates, or other machinery, or the comparative costs of isolated-plant and central-service supply. With either of these objects in view, the cost to be charged to each product for the purpose of the investigation is only that portion of the general labor charges which would be reduced by the change proposed. For ex-

ample: it would manifestly be a mistake to include, in a comparison of the costs of artificial and natural refrigeration in a hotel, part of the chief engineer's services, unless with a refrigerating plant absent these services could be dispensed with or profitably used in other directions. To determine, therefore, the cost per unit of one factor, electricity for example, for purposes of comparing it with a central supply, it would be necessary to deduct from the total cost, including fixed charges on the mechanical equipment, the "basic" cost or cost of heating and building supervision, the cost of such labor as would not be affected by the absence of the electric plant, the fixed charges on such part of the whole equipment as would not be changed by the absence of the electric equipment, such proportion of the coal, oil, water, and central-service costs as the wattmeter records show not to pertain to the operation of the electric plant. That is: the cost of the electricity in a building is the cost of the special labor its production requires *plus* a proportion of the coal, oil, water, and central service used in addition to that required for the heating and building supervision, *plus* such part of the fixed charges and repairs as is directly chargeable to the manufacture of electricity.

It is impossible to take up each type of plant in a paper of this kind, and as the general principle of the log sheet has been explained, the other parts of the system may be touched on briefly. It is important that the cost of the several items of the plant be kept separate, and I use a sheet divided by fifty-two horizontal lines and vertical lines in which weekly record is made under separate headings of coal, oil, waste, labor, engine repairs, boiler repairs, etc. The record of each plant for a year is thus kept on a single page, and comparison of one year with another is a simple matter. In addition to this account there are usual ledger and journal accounts.

To obtain supplies the chief engineer makes out once a month, and at other times when necessary, a duplicate requisition blank, one copy of which is forwarded to the office. The order is sent out, a duplicate being retained, and the material received is checked on the duplicate requisition blank, which is in turn forwarded to the office where it is compared with the order. This system checks extravagant demands and allows of competition in buying. Reports of daily operation with the summaries are delivered weekly to the office and the results tabulated. Bills are entered on receipt and the items distributed under the separate headings, after which they are filed in divided envelopes under the initial of the firm sending them. Bills are always in duplicate and separate for each building.

EDITORIAL COMMENT

The death of the Queen, which occurred shortly after our preceding issue was off the press, has called forth an expression of sympathy and respect most impressive by its universality and its depth. It affords a striking exhibition of the growth of international friendship under the influences of the era of industry—the period of the transfer of national rivalry from the political and military to the economic field. This period, practically almost coeval with the Victorian era, has witnessed the rise of substantially the whole existing system of mechanical production and transportation. It will be recalled that the Queen accepted the Bessemer gold medal of the Iron and Steel Institute in 1899, in commemoration of the marvellous advance in the iron and steel industry during her reign—advance that has amounted to complete reconstruction of plant and methods. The same period saw the first crossing of the ocean by a steamship, saw the growth of the railway, the introduction of the telegraph, the cable, the telephone, the utilisation of electric power, the differentiation of mechanical and electrical engineering as separate professions, the advance of the engineer to the place of foremost importance in odern economy.

* * *

But even more significant than this material change is the change of attitude in the matter of foreign relations which has accompanied it, and in large measure resulted from it. Fast-spreading lines of travel, of communication, of trade, have brought the nations together and promoted understanding. Common interests in foreign trade have led to common action. Competition has fostered mutual study, and has assimilated practice and with it customs and institutions. And in the general interchange of experience, first, and of sympathy next, a large value must be attached to the influence of the international exposition, of which the idea was first conceived and carried into execution by the late Prince Consort.

* * *

To the outside world the most impressive lesson of the Queen's death is the magnificent stability of British institutions and the British commercial system. Not a wheel stopped, save as a token of reverence; not a tremor in values disturbed financial centres; not an uneasiness or uncertainty as to national politics caused business undertakings to waver or hesitate. Compare this with the quadrennial upheaval in the United States, where economic legislation of every kind is the football of politics, and industry follows with uncertain feet, now artificially raised on an unstable platform of protection, now shrinking back from the morass of free silver, certain of nothing but uncertainty with every change of Chief Executive. The "demise of the Crown" demonstrates anew England's industrial strength, and those who are ready to cry her downfall before her industrial rivals would do well to remember that this stability of commercial organisation outweighs much mechanical aptitude. Machinery can be bought; skilful brains and hands can be hired; but stable political and commercial systems are of slow growth, and not soon attained.

* * *

Opinions of the value of a technical publication vary, as is the case with many other things, according to the view-point of the observer. The general reader is impressed with the manner in which interesting information is presented; and if an abstruse subject can be placed before him in an agreeable manner, he is quite

willing to be entertained while he is being instructed. The professional engineer looks for substantial information in his especial line, boiled down to the strongest degree of concentration.

The business man desires knowledge of what others are doing, and also wishes to advertise to the world his own business and his own capabilities to perform his share of the work of the world.

All of these classes of readers find ample provision for their requirements in the pages of THE ENGINEERING MAGAZINE. In the illustrated leading articles are found contributions upon subjects of immediate general and special interest, from the pens of the foremost specialists of four continents, embellished with the most brilliant work of camera, engraver, and printer. In the Engineering Index the entire field of technical literature is spread out before the worker in every department of engineering, placing him in direct touch with current thought and labour; while in the Review of the Engineering Press, the notable articles of the month, coming from England, America, or the Continent, are condensed, translated, reviewed, and criticised with care and discrimination, yet without fear or favour.

To these distinctly literary and scientific departments is added a fourth, consisting of the advertising pages, filled, it is true, with announcements of a distinctly proprietary nature, heralding forth the wares of manufacturer, engineer and merchant, yet possessing a peculiar value for all who desire to keep in touch with the vast world of business dominated by engineering interests and engineering developments.

Having provided these departments for all classes of readers, THE ENGINEERING MAGAZINE adheres strictly to the fundamental principle of maintaining each entirely distinct from all the others. Leading articles are prepared or accepted solely because of their bearing upon subjects of current or vital interest, regardless of the fact that there are advertising pages in the magazine, or even such things as advertisers in existence. The fact that the interests of an advertiser may be affected favourably or unfavourably by the statements in a leading article, or the criticisms of a review, has not the slightest bearing upon their consideration or publication.

It has seemed necessary to say these things at this time because unfortunately the habit of reasoning by analogy, although eminently unsafe as a mode of thought, sometimes leads business men of otherwise acute discrimination to suppose that THE ENGINEERING MAGAZINE permits its pages to be used in a manner to which they had become accustomed elsewhere. The idea that an advertisement becomes more valuable when disguised may permit a business man to attempt to secure such equivocal privileges; but it is only necessary to point out the uselessness of such attempts to call forth acknowledgments of appreciation of the value of the high standard set for itself by THE ENGINEERING MAGAZINE.

The following letter, from a high official in a leading engineering firm, is an excellent example of the manner in which the standard of the Magazine is appreciated:

"Instead of expressing annoyance at your declining to publish our paper in the Magazine, I shall have to say that I quite sympathize with the position you take. If THE ENGINEERING MAGAZINE were conducted on other lines than those you have laid out for it, we should probably not be carrying an advertisement in it, nor would we find ourselves especially desiring the good things we have to make first appearance in its pages. If 'write-ups' and other forms of concealed advertisements were excluded from the news pages of all engineering and trade journals, a very distinct advance would be noticeable. We should have better papers and fewer."

THE ENGINEERING MAGAZINE pays for all contributions to its pages at regular and established rates, the position of articles is governed by their importance and not by the remotest trace of business influence, and every approach or suggestion of such influence is met by communications similar to that to which the above letter is a response.

REVIEW OF THE BRITISH PRESS

Electrical Oscillations and Waves.

THE development of the theory of wave action in physics generally and the many practical applications made of late of electric oscillations and waves, render the Cantor lectures of Dr. J. A. Fleming, published in the *Journal* of the Society of Arts, most timely and interesting.

Dr. Fleming treats the subject in a thoroughly scientific manner, and yet makes it as popular as such a distinctly technical matter can be made, and his clearness of expression and the apposite nature of his illustrations are characteristic.

As in many other classes of phenomena, the controlling properties of electric currents vary with the nature of the current. In the case of continuous or very slowly periodic currents, the chief attribute of the circuit claiming attention is its resistance. The moment we begin to employ alternating currents of even moderate periodicity, the inductance begins to be important. As the frequency rises, we find that a third property, viz., the capacity of the circuit, makes its presence felt.

Professor Fleming considers first the practical method of producing electrical oscillations, and shows that while waves of moderate frequency can be produced by moving bobbins of wire to and from magnets, that this method ceases to be applicable above a frequency of a few thousand, because of the impossibility of creating the requisite mechanical movements with sufficient speed. In order to produce very rapid oscillations, another method is employed. This method is based upon the fact that when two conductors, previously brought to a large difference in pressure, are suddenly connected by a conductor of low resistance, there is set up a current of very high frequency, which gradually dies away. This action is similar to the oscillations produced in a U-tube containing mercury, for example, in which a suddenly relieved pressure in one leg will cause the level in both legs to oscillate a number of times before equilibrium is established. It is evident that this property, combined with some mechanical or chemical method of making a great number of interruptions, enables an extremely high frequency to be attained. Professor Fleming describes the arrangement of such apparatus in detail, but we have here only space to discuss some of the effects of the oscillations thus produced, together with the methods of controlling them, and to describe some of the practical applications which have thus far been made.

By the use of Leyden jars, or similar condensers, the discharges may be produced, and Professor Fleming describes the manner of connecting the condenser with an induction coil and interrupter, so as to obtain the necessary difference of potential and frequency of oscillation.

Passing from the production of oscillations to the utilisation, Dr. Fleming discusses electric resonators, and the method of "tuning" two systems so that the one will respond to oscillations set up by the other, while systems not in tune will not respond.

In the discussion of the mathematical analysis of Maxwell, the question of the electromagnetic medium is taken up, and it is shown how the observed phenomena prove that physical changes produced by one body in another at a distance can only be due to actions taking place successively at contiguous points in an intermediate medium. In other words, that there can be no such thing, strictly speaking, as action at a distance. This brings up the subject of dielectrics, in connection with which Dr. Fleming gives an account of some interesting experiments conducted by Professor Dewar and himself upon the behavior of various substances at very low temperatures. These researches showed, among other interesting facts, that liquid oxygen possesses four qualities found together in

no other substance, namely, optical transparency, almost perfect non-conductivity, a magnetic permeability greater than unity, and a dielectric constant nearly 50 per cent. greater than that of empty space. Measurements made upon ice, frozen alcohol, frozen glycerine, and many other frozen liquids showed that in all cases cooling them to a very low temperature destroys entirely their otherwise high dielectric values.

The greatest practical value of electric waves, however, is the use which may be made of them for the transmission of intelligence without the necessity for a metallic conductor. The results of the studies of Hertz appears in the so-called "wireless telegraphy" of Marconi, or as Professor Lodge prefers to name it, "space-telegraphy."

The "oscillator" of Hertz, may be understood by the diagram, the current in the primary coil inducing a difference of potential in the knobs terminating the secondary coil until the air insulation between

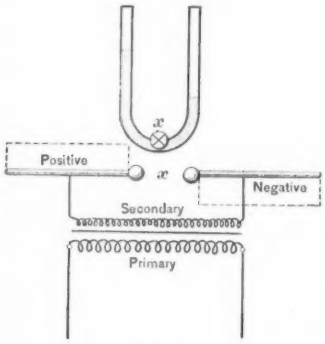


FIG. 1.

the balls breaks down, and it becomes highly conductive. Then the whole radiator becomes one conductor for the moment, and the potential difference begins to equalise itself, a curent flowing from one side to the other and creating a magnetic flux, which in turn persists and recreates electric displacement in an opposite direction. The U-tube shown over the air-gap in the sketch is intended merely to illustrate the production of oscillations by the sudden release of a strained material body.

With this apparatus Hertz used a resonator, consisting of a nearly closed ring of wire, the ends being provided with metallic balls very close together. When this resonator is placed in the range of the waves emitted by the oscillator, sparks will be produced between the balls of the resonator when the two devices are in certain relative positions. Employing these two devices Hertz found that the waves were capable of reflection and refraction, using prisms and lenses of paraffine and similar material, and in many experiments demonstrated the similarity to waves of light, heat, etc.

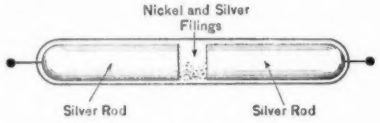


FIG. 2.

In describing the coherer, as used by Marconi to receive the impulses of electric waves, Dr. Fleming shows that the idea of employing a tube, loosely filled with metallic powder, was due to the late Professor Hughes, in 1879, but that it was Branly, in 1891, who first examined the subject with sufficient care to discover its possibilities. The most satisfactory results have been obtained by Marconi with a coherer similar to that shown in the illustration, in which a very minute amount of nickel and silver filings is included between silver plugs, only one-fiftieth of an inch apart, sealed up in a vacuous glass vessel. The passage of an electro-magnetic impulse over such a tube causes it instantly to become a conductor while it is at once brought back to a non-conductive condition by tapping or shaking.

Marconi, therefore, by skilful practical application of the Hertz oscillator and the coherer of Hughes and Branly, has been able to communicate over space without the use of conductors, as has already been widely made known. This, however, is only one of the practical uses to which electric waves may probably be put, and there could be no better preparation for the student of such phenomena who may be disposed to push forward into a most inviting field of research, than a careful perusal of Dr. Fleming's admirable lectures.

Technical Education.

In discussing the requirements of the twentieth-century engineer, and in subsequent remarks upon the relation of education to competition, *Engineering* makes some editorial remarks which will well bear comment.

"If one thing can be more surely predicted than another it is that the conditions of the future will be more exacting than those of the past. Engineers have uncorked the bottle, and let out the demon of technical education; and those who accomplished their pupilage before its advent had better make haste to grow old, and retire on their laurels—and their incomes, if they have made them—before they are smothered by the flood of learning that has been let loose. This, of course, does not apply to engineers who have made their position secure, or can bring a knowledge of affairs to the direction of a business and to exploiting the many bright young men who are only too anxious to be exploited at a sufficient salary. In all ages, however, those who can manage men and direct human efforts have taken, and will take, a higher place than those who manipulate materials. That will be true to whatever pitch technical education is brought; for as the man is a more subtle instrument than the machine, so must the operator of men have higher gifts than the operator of mechanism."

But technical education, as administered by the professors, is by no means necessarily a good thing. On the contrary, many young men who have gone through a college course with credit and distinction are often useless as engineers, and it may well be questioned if all the value which the educational institutions have given to the profession could replace the work of Watt, Stephenson, and Bessemer.

A great defect, it may be called, *the* great defect, of the present system is the inability to sort out the students according to their mental capacities and characteristics; the rowdy incompetent being, of course, weeded out altogether. The erection of a tottering superstructure on an inadequate foundation is too often the consequence of the present method of carrying a number of students of varying capacity forward at the same rate. The existing examination system makes it impossible to obtain the real average of the work of a professor. Ambitious of seeing his results high on the list, the instructor often devotes himself to three or four of his brightest pupils, and the rest do not count. If the rest really did count, if it was the professor, and not the student, who received the marks, his marks being an average of the work of all his pupils, doubtless his work would be more equably divided, especially if the results were made the criterion by which his position were determined.

"The engineer of the twentieth century will have need of all the knowledge education can bring. The nineteenth century skimmed the cream of invention; what was on the surface has been appropriated. James Watt made it impossible anyone else should have quite so brilliant a record as himself, and yet his master-stroke of invention, the separate condenser, did not need abstruse scientific attainments; although Watt was essentially scientific in his methods. So each successful worker in the field of invention does something to exhaust the soil, and render needful higher fertilisation for further productiveness. New vistas, however, are constantly being opened out, and, to continue our analogy, we have something like the rotation of crops in the changing instruments by which the engineer attains his ends.

It is becoming more and more evident that the day of the uneducated engineer, the man who by mere force of genius accomplished results which have changed the face of nature, is being replaced by the epoch of the skilled master of methods in applied science. The great surface mines have been worked, although the tailings still contain much valuable material, worthy of careful extraction. Down deep in the lower strata, however, is riches doubtless far surpassing that which has already been obtained, but it can only be reached by the keenest tools, wielded by the ablest hands.

"Whatever may be the national values of the genius and the competent man respectively, it is evident that the country that has both must be the best off. In the matter of education, what is likely to produce the competent many will also develop

the select few, supposing a proper sifting out be observed. But genius is rare, and, indeed, the simply competent are rare, so that the net must be spread wide to secure the talent that the country produces. It is here that Great Britain is falling behind many of her competitors, and the developments of the last ten years emphasise this strongly. In regard to technical education—using the term in its broadest sense, and not as confined to the schools—we, in this country, have had an incalculable advantage up to within the last few years. Every engineering factory in the kingdom has been, in the past, a school for technical education of the most efficient sort. All the academies of the Continent could not alone vie with our workshops in training mechanics and mechanical engineers, and so long as we retained an overwhelming preponderance of workshops, our engineering supremacy was assured. But from small beginnings the Continental factories, and still more those of America, have worked up to establishments of large size, employing vast numbers of men, and this, combined with the higher technical training abroad, has made extensive inroads into our former exclusive markets."

It is evident that more technical education of the kind already mainly in vogue is not needed. Carlyle has said that a king is a man who *can*, and to train up men who can, first selecting the material, and then using methods which shall arm the competent with the most powerful tools to aid him in his attacks upon the resources of nature, this is the scope of modern technical education, and the nation which does not provide it must expect to be distanced in the race by the nation which does.

Electricity in Warfare.

We have frequently referred in these columns to the important share borne by the engineer in modern warfare, and the interesting lecture delivered before the Institution of Electrical Engineers by Lieut. Col. R. E. Crompton, upon the work of the electrical engineer in South Africa, published in a recent issue of the *Electrician*, is but another instance of the manner in which applied science has been pressed into service.

The most important electrical work which it was expected the corps would be called on to perform in South Africa was that of providing electric lighting in connection with the work of the engineers, and the equipment consisted mainly of portable searchlights carried on carriages somewhat similar to those used for field artillery guns, the electrical energy being generated by dynamos carried upon compound steam traction engines. Additional electric-lighting apparatus was also carried, as well as special cable carts. A novel feature of the equipment consisted of twenty bicycles, provided with reels on which fine uninsulated copper wire was coiled, to serve as telephone conductors, and a special light and very portable type of telephone was carried. The remainder of the equipment included complete sets of repairing tools, tube wells, pumps, portable forges, etc., and experience showed the whole outfit to have been well chosen.

An early, and important part of the service of the corps soon after its arrival at Cape Town, was the construction of field telephone lines to replace telegraph lines destroyed by the enemy. This work included the maintenance of telephone communication with a flying column advancing from Bethulie to Smithfield, 1½ miles of bare copper wire, No. 22 gauge, being laid on the ground from bicycle reels.

Another important and immediate branch of work which was successfully executed was the lighting of the bridge construction work at the Vet river, where the railway construction corps of the Royal Engineers was engaged in building a main bridge with long approaches and three smaller bridges. The efficient service rendered by the electrical corps made it possible to work all night, and thus very materially hastened the completion of this undertaking. Similar work was also carried out at the Zand river, and at Rhenoster Spruit, the corps also rendering much useful service at the latter point in general engineering work.

Besides all this electrical and civil-engineering work, the corps had its share of military service, and must by no means be considered as non-combatants. For eight days the detachment was actively engaged at the front while the enemy under De Wet and Theron were threatening the line of

construction works. At Leeuwspruit the construction train was partly derailed and then atacked by Boers in ambush, and for a number of hours the electrical engineers were actively engaged in defending their outfit, which, from its importance, the enemy made desperate efforts to destroy. Instead of attempting to defend the train as it stood, the electrical engineers and other troops under their command took up a position on a ridge of rocks which ran transversely to the train, from which the train could be protected without the men being exposed. This position was held for several hours, and was so strong that the Boers could neither dislodge the troops nor approach the train, and after daybreak they withdrew from the attack. If De Wet had been successful in this attempt, securing the construction material and tools, as well as the most skilled body of reconstruction officers, the break in the line of communication would have remained open for a long period, and would have seriously affected future movements.

After arriving at Pretoria, the engineer-in-chief found quantities of electrical work for the corps, as all the forts which defend the town had been fitted up with various electrical apparatus, not only for electric lighting, but there were signal materials, telephone and other wires, which required to be sorted, labelled, and their uses understood. The oil engines which supplied the motive power for driving the dynamos had purposely been damaged by the Boers, and had to be repaired and set to work. The small and inefficient searchlights which had been used by the Boers were replaced by a system of incandescent lamps placed so as to illuminate certain points which were liable to be threatened by the enemy during night attacks.

Much of the subsequent work performed by the corps partook of the nature of general engineering, and the possession of the traction engines proved a valuable help in many ways. Several times an engine which was being used to haul 12-ton 6-in. quick-firing guns near Pretoria became stuck, and had to be assisted, and as a result the engine and two guns were placed in charge of the corps, and most efficiently handled in most difficult and important positions. Ultimately a regular steam transport service was established, using five traction engines and demonstrating the vast importance of these machines in warfare, especially in country of bad roads and scarcity of horses.

The whole work of the electrical corps, as described by Lieut. Col. Crompton, must be considered as a most important lesson in the application of engineering to warfare. Where time is of such vital importance as in military operations, the elecric light must henceforth be considered as an absolute necessity. The telephone, with flying connections made by bicycle, has demonstrated its availability. In future campaigns we may expect to see electric motors pressed into service, and manual labour in many instances replaced by machinery. The traction engine will be far more generally used than heretofore, and doubtless other motor vehicles will be employed. With all this engineering work, it can also be fully understood that engineers are fighting men, and can not only perform their own special duties promptly and well, but be depended upon to defend their equipment bravely in the face of the enemy, and rank among the "all-round men of the service," the kind of men an able commander delights to have. The keenness of perception, and ready resourcefulness of the engineer makes him most eminently qualified to be a soldier in every sense of the term.

Engineering in the Nineteenth Century.

As is customary in the first issue of each year, *The Engineer* devotes much space to a review of engineering progress in the year just closed, and at the present time this review is extended so as to include a rapid retrospect of the work of the engineer in the nineteenth century, the century of which it has been truly said that it was the first in which engineering exercised a dominating control. The century has been remarkable in very many ways, and the lessons to be learned must be presented to mankind through various mediums.

"The most noteworthy, the most impressive, of these lessons are the character, the nature, and the importance of the work done by engineers—we use this title in a very large sense. That work has con-

sisted, directly or indirectly, entirely in facilitating intercommunication. The energy of the engineer has, if we may use the phrase, been wholly kinetic. He appears invariably as the man who is making something move, or who is providing means to cause movement to take place. The mechanical engineer gives us the locomotive and the train. The civil engineer gives us the road on which they may run. The road is *the* great civiliser. Just in measure as civilisation extends, so does the demand for means of intercommunication. First came the highway. Next the canal. Then the railway. So much for the transfer of substance. The letter, transmitted by the runner, or the horseman; then by the stage coach; lastly, by the railway train, represented the primitive method of transferring thought. Next came the telegraph. That was followed by the telephone, which annihilates distance for audible speech. Last of all, for the moment, is the wireless telegraph. One step more, and the voice will be reproduced by Hertzian waves. We shall have the wireless telephone. We are within quite measurable distance of that consummation. But these and all other things like them have the one purpose and object in view. Their sole function is to facilitate inter-communication. The steamship, the railway, the telegraph, all work to the same end. What that end is can best be realised by supposing that we are suddenly deprived of them. It is said that the population of England was about 8,000,000 one hundred years ago. We know that these 8,000,000 were precariously fed. We know that famine now and then stalked through the land. The first importation of corn from the United States into this country on anything like a commercial scale took place about the year 1848, when a Belfast firm of flax spinners imported a cargo of about 600 tons of maize into Ireland, where famine was killing its thousands, not so much for lack of money as for lack of food to buy with it. Thirty millions of people could not exist in Great Britain without the aid of the steamship. Our great towns would be impossible without the railways. The fact that the important work of the country has had for its be-all and end-all locomotion—locomotion of men, animals, food, water, sewage, gas, thought, is constantly forgotten. It is in a way curious, too, to note what a very few inventions, apart from that affecting locomotion, have played an important part in civilising, received any very great attention, or made any very considerable demands on ingenuity or skill. Not a fraction of the energy expended on the transport of corn has been expended in improving the methods of its growth. Inventions concerning the comfort, the housing, the warming, the sanitation of mankind have never received the honours or conferred the awards given to aids to locomotion."

The principal result of the work of the engineer, looked at from this standpoint, is the closer union between various parts of the world because of the possibilities of transport. England long since ceased to be able to supply her population with subsistence, but the tramp steamer has brought India, America, and Russia to her doors. The material advantages of various nations are rapidly becoming the heritage of all the world, the transportation element becoming proportionally less and less important as a factor in cost. That this state of affairs involves a redistribution of industries must necessarily follow, but while intercommunication work ill for certain sections of the community it works for the greater good of all mankind.

"Thus the English agriculturist has suffered, because he depended for prosperity on the isolation of the country. But even the farmer himself begins to see that he has not suffered for nothing, and that even his life is not without recompenses and satisfactions. There is, however, one national advantage which is largely independent of the means of transport, and which is, we think, the unfailing heritage of the people of this country and of her sons and daughters distributed all over the globe. It is that world-surprising combinations of audacity, sagacity, endurance, talent, and genius, which seems to be the birthright of our race, and the certain means of maintaining Great Britain's position. Furthermore, if this little island disappeared tomorrow, so long as its population remained alive the world would not lack rulers of men, masters of nature, and supporters of right. It is with no pessimistic spirit that

we begin a new century, though foreign competition may threaten us at home and abroad. We know that, like the mills of the gods, though Britons grind slowly, they grind surely. With each difficulty will come the way of escape."

The reviews of the various branches of engineering as it exists at the close of the century give an excellent idea of the position of man with regard to the forces of nature, showing how he is prepared to make the attack anew, and along what lines progress may be expected.

In civil engineering, bridge work showed no new development, but has continued along lines already well developed. Subways and tunnels, especially for metropolitan traffic, have made notable progress, as in London, Paris, and New York. Railway developments in all parts of the world have been progressing, carrying trade and civilisation with them: witness Siberia, India, and Africa. Water supply and sanitation are making good progress, and would advance more rapidly if they depended solely upon the work of the engineer unhampered by the politician.

Mechanical engineering has progressed well. The steam engine, thanks to the possibilities of electrical distribution of power, is being made in larger and more efficient units than ever; the water-tube boiler is firmly established both for marine and stationary service. The internal combustion motor, whether for use with gas or liquid hydrocarbons, has made long strides, and the capacity of large engines has advanced from 200 or 300 horse-power to 1,000 horse-power and over for single-cylinder motors, while the use of furnace gases has become an established fact. Locomotives are heavier and more powerful than ever. Artificial refrigeration is meeting with extended applications. Mechanical engineering is extending its realm more and more into other lines of practice, and it is evident that it is destined to absorb nearly every department of engineering industry.

In electrical engineering there is little to record in power applications, except to enumerate a list of hydraulic and other generating stations, with their transmission and distribution systems. Communication has had added to its resources improved high-speed writing telegraph devices, and the range of long-distance telephony has been greatly extended, while submarine telephony has come within the bounds of possibility.

The advance in metallurgy has mainly been along the line of greater productivity, and the enormously increasing use of steel in all branches of construction continues.

All departments of engineering have been developed to an extent hitherto unprecedented, and the dependence of the material progress of the world upon the work of the engineer was never so fully emphasised as at the close of the nineteenth century.

Coal Cutting by Machinery.

WITH the increasing price of coal has come a general interest in methods for cheapening the cost of mining, and hence it is not surprising that the use of coal cutting machinery should be the subject of various articles in recent issues of the *Colliery Guardian*. A series of editorial papers, beginning with a historical introduction and following with examples of practical application, forms a very practical contribution to the subject of modern coal mining. Without attempting to go into detail, the advantages of coal cutting machinery may be briefly enumerated.

In the first place, the machine possesses the ability to do the work at a smaller cost than is possible with hand labour, and this is true whether in long-wall, or pillar-and-stall working, as well as driving headings. A comparison of costs at various collieries shows the saving to range from 4d. as a minimum to 3s. per ton, a fair average being one shilling per ton.

Since the cost of cutting by hand varies with the character of the seam, it follows that the greatest economy results from the use of machinery in thin seams, but it is from this class of seams that future supplies must be largely drawn. An extreme instance of this is found in a case where Messrs. Gillott claim to have won a seam of valuable cannel, only 3 inches in thickness, in which the cutting price by hand ranged from 20s. to 14s., at an economy of just one half, by the use of machines.

The wastage by the use of machinery is also much less, and the time element should also be considered for other reasons than those of mere labour cost, while the hu-

manitarian side of the question is one which stands by itself in importance.

The colliery, like all other branches of human industry, must surely yield to the pressure for the replacement of human labour by machinery, and there is no department of work in which its advent should be more heartily welcomed.

Electric-Power Distribution.

ELECTRICAL distribution of power has frequently been treated from the standpoint of the electrician, and for this very reason the paper of Mr. W. B. Esson, upon the case for electric-power distribution, presented before the Civil and Mechanical Engineer's Society, and published in the *Electrical Engineer*, is especially acceptable.

Leaving out of consideration the problems of transmission, Mr. Esson confines himself to the question of electric distribution of power in workshops and factories, and relegating to the electricians the discussion of the relative merits of continuous and alternating currents, he considers mainly the subject of the displacement of the older methods of transmission by the newer.

Taking up first the mechanical methods, so-called, for the distribution of power, their inherent wastefulness is clearly shown. Small steam engines are necessarily uneconomical, even when in perfect condition, while as actually employed they are far more wasteful than any other practical form of power subdivision.

The losses in shafting and belting have often been investigated, and while there are necessarily many variations, it appears in general that the loss ranges from 40 per cent. at full load to more than 70 per cent. at quarter load.

The margin for economy is therefore great, and it remains to be seen to what extent electrical subdivision and distribution of power can be expected to show a greater saving.

Taking a direct-connected generating set, the dynamo being mounted on the engine shaft, a useful return of 90 per cent. may be expected in the form of electrical energy, and allowing 10 per cent, for engine friction, we have at the generator terminals 81 per cent. of the indicated horse power of the engine, taken at full load. For part loads the efficiency falls off to about 71 per cent. at half-load, and 56 per cent. at quarter load. A similar relation exists as to motors, except that the use of a number of motors permits the safe assumption that the mixed sizes and loads will give a general average efficiency, which is decidedly higher than is attainable with shafting and belts.

By means of a diagram of motor efficiencies Mr. Esson shows that for full load an efficiency of 66 per cent. is obtained for electricity as against 60 per cent. for shafting, while at quarter load we get 44 per cent. as against 27 per cent.

Coming as this endorsement does, from a civil engineer, before a society of civil and mechanical engineers, it is worthy of especial consideration, as being free from bias or prejudice.

Submarine Boats.

SUBMARINE warfare has so many attractions to the popular mind that it is with satisfaction that we note the appearance in the *Engineer* of papers showing what has really been already done in this direction, and what the possibilities really are. As a matter of fact there are certain limitations, which should be appreciated before either undue alarm or undue enthusiasm is excited.

For a full discussion of the subject the reader must be referrred to the papers above mentioned, but the salient points may be here enumerated.

High speed is a practical impossibility, because submarine navigation requires more power than similar displacement demands at the surface, while there is far less space available for motors. The limitations of steam are well known. Oil motors of the internal combustion type require even more space for equal power, while electric storage is also handicapped by bulk and weight, as well as necessity for frequent charging. Carbonic acid, or liquid air might be employed if their claims could be made good practically, but at present they do not respond to the demands of the service.

Bearing these points in mind, the *Engineer* proceeds to examine the performance of existing boats, mainly with a view of finding out what they cannot do; a laudable object, with the one weak point that no logical conclusions can be drawn from negative premises.

Multiplex Space Telegraphy.

ALTHOUGH "wireless" telegraphy has been in public use for several years, and has been found very serviceable for communicating with ships at sea, and with isolated stations not to be reached by cables, a serious objection to its more general employment has been the lack of any selective system of signalling.

A train of waves sent out from a station would influence all the receivers within the transmitter's radius of action, and, conversely, a receiver was subject to the influence of all the transmitters within its range of susceptibility. This meant, practically, that only one instrument could "speak" at a time, for if two stations tried to communicate simultaneously with a third, there resulted an inextricable confusion of signals.

Naturally, the workers in space telegraphy have long striven to overcome this difficulty, but it has remained for Prof. Slaby, of the Charlottenburg Technical High School, to reach a solution of the problem, at once scientifically elegant and beautifully simple.

It may be remarked, in passing, that he was induced to undertake his experiments by the desire to provide the German navy with a system of wireless telegraphy which would not conflict with the Marconi patents, as the English Marconi company demanded a price for the use of its system which the German government was disinclined to pay. Prof. Slaby investigated the subject in a thoroughly scientific spirit, and while in the beginning he hoped for nothing more than to devise methods which would be as good as Marconi's, he has now gone far beyond anything hitherto attained in the field of "spark telegraphy," as he prefers to call it.

In a lecture delivered in Berlin before a distinguished audience, including the German Emperor, and reproduced in a recent number of the *Electrotechnische Zeitschrift*, Prof. Slaby has given an interesting account of his inventions, the leading points of which may here be briefly touched upon.

The lecturer, after a general introduction, gave a mechanical illustration of vibratory motion. If a steel rod has one end clamped in a vise, and the free end be struck, the rod will execute regular vibrations, the amplitude of which will be greatest at the free end and diminish to practically zero at the fixed point. These oscillations can be communicated beyond the fixed point by clamping a wire at its middle, and setting one free end in vibration, when the other free end will execute vibrations of the same rate and amplitude. Considering this as a case of wave motion, the free ends constitute loops and the fixed point is a node, the distance from a node to a loop being just one-quarter of a complete wave length.

Now in space telegraphy there are electric oscillations set up in the vertical wire at the transmitting station; the frequency of these oscillations, and consequently their wave-length, being determined by the length of the wire, which, as in the case of the steel rod, will be one-quarter of the complete wave-length. These waves are propagated outwards through the ether and when they fall upon the receiving wire, they set up oscillations therein, which are most powerful when the wire's natural rate of electrical oscillation corresponds with the frequency of the incoming waves. This will be the case when the wire is just one-quarter of the wave length and when its lower end is a nodal point. The length of the wire can be determined with great exactness and its lower end can be made a nodal point of the electrical oscillations by connecting it directly to earth. In this way the favourable conditions for great amplitudes can be attained; the lower point being earthed, will be at zero potential, while at the upper free end of the wire the rapidly oscillating potentials will be highest.

It would appear, then, that in order to get the best results, the receiving apparatus

should be at the free end of the wire. This requirement has apparently not been recognised hitherto, for the coherer has always been connected to the lower end of the wire, or at the point of minimum effect. That the apparatus has worked at all is due partly to the extreme sensitiveness of the coherer and partly to the circumstance that the lower end of the wire will not be exactly at a nodal point for the fundamental wave length unless the wire is of the same length as that at the transmitting station, and even if the length of wire be the same at both stations, there will be harmonics impressed on the fundamental wave which will cause irregular oscillations on the receiving wire sufficient to affect the coherer. The dependence of the coherer upon these irregular oscillations is probably accountable for its erratic behaviour in the systems hitherto in use.

There are, of course, practical objections to placing the coherer at the upper free end of the wire, but Prof. Slaby attains the same result by simply prolonging the wire an equal distance beyond the nodal point. This extension wire need not be straight, but may be wound on a reel, and at its free end, which can be placed in any convenient position, there will be developed oscillations of the same amplitude as at the upper free end of the vertical receiving wire, and the coherer, placed at the free end of the extension wire, will get the full benefit of these great amplitudes.

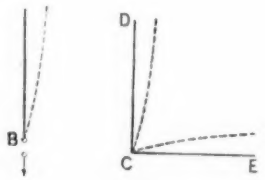


FIG. 1.

In the accompanying diagram, B is the vertical transmitting wire, sending out waves four times as long as itself; CD is the vertical receiving wire, directly earthed at C and thus forming a node at that point, but also prolonged beyond to E, CE being made equal to CD. The potentials at E will be as great as at D, and a coherer placed at E will get the maximum effects of the oscillations.

The extension wire is the essential part of Prof. Slaby's invention, and besides greatly improving simple transmission, it makes possible the long-desired multiple signalling. The arrangement of wire just described will respond to waves of only one length. Waves of all other lengths will go to earth at C, which is not a nodal point for them, and will never reach E.

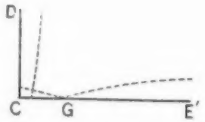


FIG. 2.

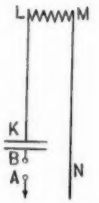


FIG. 3.

But it is found that if another extension wire, CE', be joined to the lower end of the air-wire at C, so that the total length of air-wire plus extension wire is just half of the new wave-length, then a node will be formed at G, midway between D and E', only a negligible part of the new wave's energy will go to earth at C, and maximum oseillations will be produced at E'.

In this way it is possible to simultaneously receive as many messages as there are extension wires, each of the latter plus the air-wire, being of a length equal to half that of the waves emanating from the corresponding transmitting station.

It only remains now to provide a transmitting apparatus which shall send out waves of a given length. Prof. Slaby reaches this result in a way by which he obtains powerful oscillations, as well as absolute control over the wave-length.

Instead of a single vertical insulated wire, he has a circuit, grounded at N, the branch MN being connected to the actual transmitting wire through the induction coil LM. In charging, the whole circuit is used, and a large amount of energy thus made available, but when the rapid oscillatory discharge takes place, the choke-coil LM allows no oscillations to pass through it and only that part of the circuit between K and L is effective in sending out waves. The length of these waves is completely determined by the length of wire between K and L and the capacity of the condenser at K.

It is apparent, then, that there is entire control over the wave-length, that receiving

apparatus can be perfectly tuned so as to respond to only one wave-length and that at a single station there may be any number of receivers, each actuated only by its corresponding transmitter. Complete secrecy of transmission is thus attained, unless the wave-length of the transmitter be known, and any number of messages may be received simultaneously.

It might seem that with this the ultimate goal of space telegraphy, leaving the question of distance out of consideration, had been reached; but Prof. Slaby was not satisfied to stop at this point, and with scientific zeal he and his assistant, Count Arco, have devised various improvements which can only receive the barest mention here.

The effects at the receiving apparatus are still further strengthened by inserting a properly tuned induction coil between the free end of the extension wire and the coherer. The coil, which Prof. Slaby calls a "multiplicator," acts like a resonator, absorbing the oscillations on the receiving wire and giving them out again at a higher potential, thus producing a more powerful effect on the coherer.

Finally it has been found possible to dispense altogether with earth connections at the receiving wire by an arrangement which in its latest and simplest form is due to a happy inspiration of Count Arco.

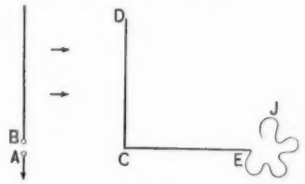


FIG. 4.

DCE is the receiving wire already described, equal to half a wave-length. If, now, there be added at the end of E another wire EJ, also equal to half a wave-length, there will exist between E and J a difference of potential twice as great as between E and earth, and if the coherer be placed between E and J the effects upon it are doubly intense.

Experiments are to be made with German naval vessels in order to determine the maximum distance at which signalling with this improved apparatus is possible.

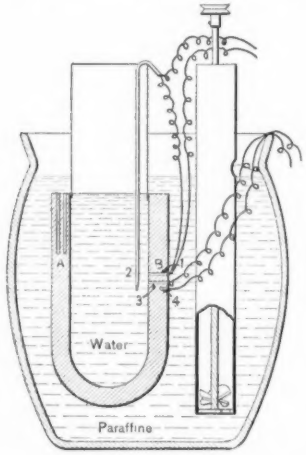
The Transmission of Heat Through Metals.

ONE of the elements in boiler design about which there has been but little definite information up to the present time, is the question of the transmission of the heat from the fire on one side to the water on the other. With this is also to be considered the very important matter of the relative temperatures of the two sides of the metal plate with regard to the extent to which the water protects the metal from the injurious and weakening action of the heat. Increasing pressures and dimensions have made it most desirable to employ thicker plates in boiler construction, and in the United States one of the large steam boiler insurance companies has announced the willingness of its engineer to accept greater thicknesses of metal exposed to fire than have hitherto been thought advisable. For this reason the investigations which have been carried on at the Physikalisch-Technischen Reichsanstalt upon the transmission of heat through metal plates, conducted by Messrs. Holborn and Dittenberger, and published in the *Zeitschrift des Vereines Deutscher Ingenieure* are of much interest, and furnish fuller data than were previously available.

The early researches of Péclet, upon which the general ideas of engineers are based, assumed that the transmission of heat depended upon the conductivity of the metal, but practical experience in steam heating has proved that the rate of transmission of heat depends to a very great extent upon the motion of the fluids in contact with the metal, this introducing into the problem an element very difficult of measurement.

In the experiments made at the Reichsanstalt it was attempted to make the results comparable by maintaining the same circulation in all cases, so that the disturbing element should be removed, rather than determined. Briefly, the apparatus consisted of a vessel of brass with comparatively thick walls, the metal being 2 centimetres thick, this containing water and being immersed in a larger vessel containing paraffin, palmin, or other substance having a comparatively high boiling point. In the outer vessel was also placed a tube open at the bottom and the surface of the liquid, and containing a small propeller, revolved by an

electric motor. For a constant speed of the propeller the circulation was maintained at a practically uniform rate during any series of experiments. In the walls of the inner vessel were imbedded thermoelectric elements, placed at different depths, both radially and longitudinally, and by these means the relative temperatures of the metal at different points were determined. The whole arrangement is clearly shown in the illustration. At 2, there was introduced a thermoelement in a glass tube immersed in



the water close to the point where the measurements in the metal were taken, and so all the elements for determining the rate of transmission of heat through the walls were given.

The results of several series of measurements are given in the paper, tabulated in a form convenient for comparison, and by the method of least squares the coefficients for the formulas of the authors were deduced. Although these formulas were deduced for the particular brass employed in the experiments, the constants can readily be modified for any other material of which the conductivity is known, and the coefficients for iron are given in the article. These formulas enable the computation of the number of heat units transmitted per square metre of heating surface per hour for a given difference of temperature, the whole forming a valuable contribution to an important branch of applied science.

The Regulation of Steam Engines.

One of the marked improvements which has been made in modern steam engines is the closer regulation obtained, and this is in response to a well understood demand. The closeness of governing, however, is not altogether dependent upon the governor itself, as a governor may do well upon one type of engine and not so well on another.

The subject of the relation of the engine itself to the method of governing and form of governor forms the matter of a paper by M. Delaporte, published in a recent issue of the *Revue de Mécanique,* and although the treatment is too mathematical for full discussion in these columns, the general line of reasoning may be outlined.

M. Delaporte, for the sake of simplicity, assumes a governor of a type well known, in which the centrifugal force of a revolving mass is opposed by the tension of a spring, and also assumes that the friction is negligible and that the valve is exactly balanced.

The admission of steam into the cylinder of an engine is discontinuous, but with high-speed engines the oscillations in the governor are much longer in duration than the time of a single stroke of the engine. It is therefore assumed that the flow of steam from the chest into the cylinder may be considered as practically continuous. Since the mean exhaust pressure, whether into a condenser or against the atmosphere, is lower than 0.57 of the pressure in the steam chest, we may, according to Napier's law, consider that the flow is directly proportional to the density of the steam and to the size of the opening.

Taking these premises it appears that the size of the steam chest, *i. e.,* the volume of steam between the governor valve and the cylinder, exerts an important influence upon the regulation, the exact relation being expressed mathematically in a formula including the pressure in the steam chest. The closest regulation is secured by having the smallest practicable space in the valve chest, but this naturally affects the initial pressure in the cylinder, and requires a somewhat larger cylinder to produce the same power.

The weight of the fly wheel also enters into the solution of the problem, and in general terms, for a given engine, with a determined volume of steam chest, the weight

of the fly wheel should increase in proportion to the increase in steam pressure, a fact which is confirmed by experience as well as theory. With a governor of the type under consideration, having a revolving mass opposed by a spring, isochronism and stability cannot be attained together, since the equations show that for such a result the weight of the fly wheel should be infinitely great.

It is impossible to follow the anaylsis of this interesting paper without going too extensively into the mathematical discussion, but it touches a field in steam engineering but little worked.

The Commercial Influence of the Siberian Railway.

MUCH has been said and written about the Siberian railway from the point of view of construction, but as the work upon this great undertaking approaches its completion, its commercial and industrial signfication looms up as a subject of vast interest, not only to the engineer, but also to the manufacturer and business man. In fact, the work of the engineer is becoming so closely bound up with industrial and commercial interests that it is neither possible nor desirable that they should be considered other than together.

For these reason the papers of M. de Krivochapkine upon the economic influence of the Transsiberian railway upon the mineral industry of Siberia and upon international commerce, published in recent issues of *Le Génie Civil*, merit extended review and discussion.

Although Siberia has formed a part of the Russian empire since the close of the sixteenth century, the entire control of the country to the Pacific coast was not completed until 1860, when the treaty of Pekin recognised authoritatively the Russian possession of the entire Amoor region, and thus opened the way to the sea of Japan. About the same time the abolition of serfdom in Russia caused a strong tide of emigration towards Siberia, this being wisely encouraged by the emperor Alexander II. as the best means of advancing the value of the Asiastic portion of the empire. It was only in 1891, however, after the travels of the Hereditary Grand Duke Nicholas, now Nicholas II., to the Far East, that the execution of the great projects for the development of Siberia were actually begun.

As has already been described at various times in these columns, the Transsiberian railway, begun in 1891 at Vladivostok, on the Pacific, and in 1892 at Tcheliabinsk, on the European frontier, is divided into six great divisions:

1. The Western Railway of Siberia, from Tcheliabinsk to Obe, 880 miles.
2. The Central Railway of Siberia, from Obe to Irkoutsk, 1,137 miles.
3. The Circum-Baikalien Railway, skirting around Lake Baikal, from Irkoutsk to Missovaia, 686 miles.
5. The Railway of the Amoor, from Stretiensk to Khabarovsk, 1,380 miles.
6. The Oussouri Railway, from Khabarovsk to Vladivostok, 475 miles.

The Circum-Baikalien Railway is not yet in operation, being at present replaced by the railway ferry across Lake Baikal, while the railway of the Amoor has been abandoned in favour of the later route through Manchuria, all the other sections being now in actual operation.

In the place of the railway along the valley of the Amoor there has been substituted the Eastern Railway of China, this reducing the total distance from Tcheliabinsk to Vladivostok to 3,967 miles, and from Tcheliabinsk to Port Arthur to 4,242 miles.

M. de Krivochapkine discusses both the constructive features of the railway and the resources of the various sections, but as the former have already been recently examined in detail in these columns, we shall review mainly the latter points.

The western railway of Siberia traverses mainly an agricultural country, already well developed both as a grain-raising district and a region of grazing and the breeding of horses and cattle. Although there are as yet no mineral undertakings developed in this country, it is believed that deposits of gold, copper, argentiferous lead, and petroleum exist in the Altai mountains, and that the proximity of the railway will accelerate their development. In 1898 the western railway of Siberia carried to Europe 280,407 tons of cereals and 112,713 tons of general merchandise, and from 1896 to 1898 there was an immigration of 280,000 persons to this section. Each male emigrant is given 40 acres of government land, with an ex-

emption of three years from taxation, and a further exemption of three years immediately following the return from military service.

The central railway of Siberia traverses an altogether different kind of country, mountainous and heavily wooded. This section of the railway crosses the Yenesei river at Krasnoiarsk, there being steamers of light draught navigating the river at this point and connecting with the deep-water navigation of the Yenesei starting at Yeneseisk and reaching to the Arctic ocean. This section of the railway traverses the mineral portion *par excellence* of Siberia. Here, in the Government of Tomsk, lies the portion of the Altai mountains known to the Chinese as the Gold Mountains, with a mean altitude of 5,000 feet above sea level, the highest peak being Bieloukha, 11,650 feet high. Here also is the great Katounsk glacier, nearly eight miles in length. The gold of the district is found in an auriferous quarts and also in the placers of the districts of Mariinsk, Kousnetsk, Biisk, and Barnaoulsk; the last official report showing an annual production of 3,423.420 kilogrammes of gold. There are 124 placers in the Altai region, the sand containing 0.540 grammes to 0.800 grammes of gold to the metric ton (about 0.019 oz. to 0.028 oz. to the ton). There are also 800 mines of silver, copper, and lead in the Altai district, and in various parts of the Government of Tomsk are extensive deposits of iron, coal, and salt. There are quarries of marble, and other valuable stone at Biisk, and jasper, porphyry, and agate are freely found. In the western part of the section traversed by the central railway of Siberia, in the Government of Yeneseisk, gold is extensively found, being distributed generally over the whole of this immense area and concentrated in the valleys and along the watercourses. The exploitation of the Yenesei region began in 1839, since which time there has been produced 442,260 kilogrammes of gold. The greatest production was between 1839 and 1850, when it reached 16,500 kilogrammes per year, in spite of the most rudimentary methods of washing; and at the present time it is found profitable to rework the tailings left as valueless at that early date. Most of these deposits are placers originally beneath several feet of earth, and in most cases the workings are open to the surface, or in some cases are in galleries or tunnels beneath to perpetually frozen ground.

Silver and copper are frequently found in the Yenesei valley, the silver occurring in the form of an argentiferous galenite, mingled with copper pyrites. There are also extensive deposits of iron in the form of magnetite, as well as coal and graphite; the extensive deposits of graphite at the Alibert mines are in the Government of Irkoutsk, and have been worked for a long time.

The region of the railway in the neighbourhood of Lake Baikal has been fully discussed in these columns last month, with especial reference to the heavy ice-breaking ferry boats used pending the completion of the Circum-Baikalien railway. This portion of the country has been as yet but little explored, but there is every reason to believe that it will be found rich in mineral resources. Petroleum has already been found in the vicinity, and the geological character of the country is similar to the auriferous localities already worked.

Beyond the Baikal region the mineral riches of Siberia are remarkable. Iron, in the form of magnetite is abundant, and coal has been already found in twenty different localities. The gold placers of the district, mainly government property, have been worked for nearly a century, the output of the imperial mines now being 3,734.640 kilogrammes per year, and increasing, while there are 206 private claims being worked. Silver, lead, and copper are also found, and here the only deposits of tin in the Russian empire.

The Ossouri railway, extending northward from Vladivostok to Khabarovsk was originally intended to form the connection to the Amoor branch of the main line, and was the first section constructed; but with the abandonment of the Amoor division in favour of the Eastern Railway of China, as the Manchuria section is called, the Oussouri railway has become practically a separate road connecting the Amoor with the Pacific seaport.

In conclusion the following summary may be given:

In the nine years from 1891 to 1900 the administration of the Transsiberian Railway, composed entirely of Russians, and using Russian material, has constructed 3,354

miles of railway, or about 375 miles per year. The cost of this great work has been more than 1,000 million francs. No other railway of such importance has been so rapidly built; the nearest approach being the Canadian Pacific Railway, about 2,900 miles long, having been built in ten years.

It is impossible to enlarge upon the manifold consequences which must follow the opening up of this wonderful region to the commerce of the world. Not only must there follow a marvellous extension of the mineral development of the regions here briefly mentioned, but all the great industrial and commercial results of the influx of immigration into a vast agricultural country will surely come.

The Evolution of Science.

In pronouncing his annual address as retiring president of the Académie des Sciences, M. Maurice Levy gave a remarkable review of the evolution of science during the only century in which scientific thought and work have dominated the progress of civilisation. The address is given in full in the *Comptes Rendus* of the Academy, but abstracts of certain portions will be appropriate in this place.

Starting with the admitted fact that practice in nearly every instance has preceded theory, and that theory has then enabled practice to advance to further improvements, M. Levy rapidly reviews the history of science in previous centuries in order to discover why the evolution of science has progressed but slowly until recent times. Nearly all the fundamental phenomena of the various branches of science have been observed during many centuries, and only after long lapse of time have these principles been developed and applied with that system and judgment which may truly be called scientific.

Thus, for example, the attraction of the lodestone for iron and steel was known for ages, but it was not until the expansion of navigation in the fifteenth century that the compass came into use. The philosophers of Alexandria were familiar with the force imparted by heat to vapour of water, but it was not really until the commencement of the nineteenth century, after the expiration of the patents of Watt, that the development of the steam engine really began, and not until the formulation of the science of thermodynamics in the latter half of the century, that the improvements were made which enabled a horse power to be obtained with one-fourth to one-fifth of the fuel consumption formerly necessary. In this connection M. Levy calls attention to the remarkable prediction of Oliver Evans concerning, not only the development of the locomotive engine, but also of the automobile, the latter prediction requiring practically the entire century for its accomplishment, although all the data for its full realisation were in existence in Evans's own time.

A number of such examples might be given, but the facts are sufficiently well known, and hence M. Levy passes to the query as to why the systematic evolution of science and scientific methods have been almost entirely reserved to the century just closed. The answer he finds in the liberation of thought, by which alone it was made possible for the phenomena of nature to be studied intelligently, without the trammels of preconceived and erroneous notions.

Starting with the great work of Newton, and following with that of Laplace, d'Alembert, Lagrange, and Lavoisier, the field was prepared for the application, in the nineteenth century, of scientific methods to the study of observed facts. In this work the position of pure science, so-called, must not be overlooked. What in one age appears almost a vain speculation, without practical application, becomes in a succeeding period a vital factor in material progress. We must not forget that if applied mechanics to-day enables us to compute and determine in advance the strength and motion of the organs of the most complex machines, it is because in former ages the shepherds of Chaldea and Judea observed the stars; because Hipparchus collected their observations with his own and transmitted them to succeeding generations; because Tycho-Brahe continued and perfected them; because, two thousand years before, Apollonius of Perga produced a treatise on conic sections, regarded as useless by many following generations; because the genius of Kepler, uniting the work of Apollonius with the observations of Tycho-Brahe, gave us the sublime laws which bear his name, although deemed useless by the practical men

of his day: and finally, because, from all this pure scientific work of his predecessors, Newton deduced the law of universal gravitation.

The share of France in the evolution of science in the nineteenth century has not been small, and M. Levy enumerates a list of notable names in various departments of work. Thus we find that Navier, Cauchy, Poisson, Lamé, and de Saint-Venant created or perfected the science of molecular mechanics. Navier, Clapeyron, Bélanger, and Bresse advanced the knowledge of the resistance of materials. Pancélet, by the publication of the "Leçons de l'Ecole de Metz," created the science of industrial mechanics subsequently developed by Coriolis, Bélanger, Résal, Phillips, and others. Borda, Dupin, and Reech perfected the art of navigation and the theory of ships, while Poinsot threw a brilliant light upon the whole range of mechanics by the introduction of the notion of couples.

Thus, from the untrammeled application of scientific thought to observed facts, all has been resolved into matter and motion. Heat is motion, light is motion, as is also electricity; and all special theories of peculiar fluids, special forms of matter, etc., have been abandoned. Whatever may be the revelations of the near future, the great doctrines of the nineteenth century will long remain at the foundation of all science and of all human industry. By their generality, by their strength, and by their simplicity, they offer the widest and most secure base for a structure which may lead to developments which, while not to be predicted with certainty may at least be indicated in character.

The Influence of Heat on the Strength of Bronze.

THE increasing use of high steam pressures and the applications of superheated steam render it most desirable that fuller knowledge should be had as to the effect of heat upon the strength of the materials used in steam connections, especially such copper alloys as are so generally employed for pipes, valves, valve-chests, etc. An extensive series of experiments have been made by Professor Bach upon the behaviour of bronze under high pressure steam and from his paper in the *Zeitschrift des Vereines des Deutscher Ingenieure* a brief account of the experiments and the most important conclusions may be taken.

The experiments of Professor Bach were made upon the standard bronze used in the government shipyard at Kiel, the composition being, in percentages, copper 91, zinc 4, tin 5. A number of test pieces of this bronze were tested at atmospheric temperature, about 20° C. or 68° F., showing an ultimate resistance of 36,000 pounds per square inch, with an extension of 36.7 per cent., and a reduction in sectional area of 47.4 per cent. Tests were then made upon similar pieces at temperatures from 100° C. to 500° C., advancing 100° with each set of four tests, the results being tabulated and plotted as curves.

Without going fully into the details of the tests, for which the paper of Professor Bach must be consulted, the following results are given:

	100°	200°	300°	400°	500°
K	34.500	30,200	19,450	8,900	6,280
p	35.4	34.7	11.5	0	0
q	47.4	48.2	16.2	0	0

In which K is the ultimate strength in pounds per square inch, p the percentage of elongation, and q the reduction of cross section.

According to these results it is evident that a bronze of this composition should not be used for pipes, valve chests, etc., in which the temperature of the steam exceeds 200° C., corresponding to a pressure of about 300 pounds pressure per square inch absolute, and that in no case should temperatures of 300° C. be reached.

Although the investigations of Professor Bach have thus far been confined to the bronze of the composition above noted, yet it is probable that nearly all copper alloys are similarly affected, although the rate of diminution in strength probably varies somewhat with the composition. It is therefore advisable, in designing machinery for use with high-pressure or superheated steam, that the material to be used should be tested under temperatures somewhat exceeding those which are to be attained in practice, and the behaviour noted, and it is altogether possible that some apparently mysterious fractures have been due to the unsuspected weakening influence of heat.

REVIEW OF THE AMERICAN PRESS

Electric Traction for Heavy Service.

ELECTRIC traction is making strong headway, for consideration at least, in connection with heavy service and main-line conditions, and one of the strongest presentations which has yet been made of the case for electric traction is the paper of Mr. Edward P. Burch presented before the Northwest Railway Club.

After reviewing the development of electric traction for city and suburban purposes, as well as the special service of the intramural railway at the World's Fair at Chicago in 1893, and later installations, Mr. Burch proceeds to examine the growth of material for heavy service. Without going too fully into questions of construction he gives the examples of what has been done in shifting and tunnel engines as sufficient evidence of the capabilities of the electric locomotive.

"In 1895, the Baltimore & Ohio R. R. put in service three heavy electric locomotives for hauling standard passenger and freight trains through the B. & O. tunnel under Baltimore. Each locomotive weighs 194,000 lbs., all on the drivers. They are rated 1,500 h. p. each. A draw bar pull of 60,000 lbs. is easily obtained, and trains weighing 1,900 tons have been hauled up the 42-ft. grade at 12 miles per hour. Ordinarily each locomotive hauls 1,400 tons on the level at 15 miles per hour. Faster work can be done with these locomotives than with the steam locomotives. The management states that they thus save in the track required. They are handier, accelerate rapidly, yet are much less liable to break a train in two in starting. The advisability of extending the use of the electric locomotive on an 80-mile division of the road is now under consideration. In 1896, two 660-h. p. electric locomotives having 136,000 lbs. on the drivers, were installed on the Buffalo & Lockport Railway for switching purposes over the tracks of the Erie R. R. Twenty loaded cars are commonly hauled.

"Since these early installations, hundreds of heavy electric switching locomotives have been purchased for use in railroad yards, terminal railways, belt lines, at factories, steel mills, etc. Two hundred electric mining locomotives have been sold by one manufacturing company within two years. Great advance may be expected from the consolidation of interests of one of the steam locomotive builders with a leading electric manufacturing company.

"It is thus evident that conservative railroad managers, who are convinced of the advantages of electric traction as a matter of commercial economy, will now have plenty of precedent for their guidance."

Coming now to other questions than those of the capability of the electrical engineer to provide the motive power, Mr. Burch proceeds to dispose of some of the objections which have been made.

"Electric traction applied to steam railroads will or should mean very few radical changes. Consider the adoption of electric power on some railroad having, say, five or more trains in each direction daily, for example, on any road radiating from the Twin Cities, to Fargo, to Duluth, the Soo, to Chicago, or to Omaha. The water tanks, with their coal depots and usual attendants machinery, trestle work and buildings, will be consolidated in a few advantageously located central power stations. The locomotive tender, with its coal and water load, its repairs and depreciation, will be absent, and power will not be necessary for its propulsion. All the locomotive boilers and engine cylinders, the piping and accessories will be exchanged for a few large and economical steam producers and prime movers. Fewer locomotives will be necessary, as each will be capable of higher speed and greater annual mileage, a smaller proportion also being in the shops. Some of the locomotive firemen may be utilized in the power stations. The steam locomotive is short-lived and is either rebuilt, worn out

or a drag on the service after 10 years' work. The mechanical superintendent need not worry about a larger scrap pile. Ordinarily the steam locomotives will be used up, on divisions not equipped for electric traction, or sold. The heavy electric locomotive will simply be substituted for its steam rival. The balanced working parts, general simplicity and ease of control will commend it. In addition to the substitution noted above, which will save an immense amount in depreciation, heavy additional investment will be necessary for metallic conductors to transmit the electrical energy, transformers (located at ticket stations), and working conductors for the electric motors."

From the operating standpoint the advantage lies with electric traction. Taking the reports of the Inter-State Commerce Commission, it appears that the repairs of engines and roadbed, water supply, wages of engine and roundhouse men, and fuel, make up 36.7 per cent. of the total operating expenses of railways. Examining these items for electric traction it appears that marked savings can be made in all of them. Besides this, the steam locomotive has already reached the limit of capacity in certain directions, while the demand for increase remains unsatisfied. This is especially the case with regard to the boiler, which the limit of gauge prevents being made larger.

"The gauge does not limit the design and the capacity of the motors in electric locomotives. The steam locomotive has its source of power upon its back. The electric locomotive has the entire power station behind it. In steam locomotives, the moving parts reciprocate, and thus the speed of passenger trains is limited. The moving parts of a motor rotate. Likewise, the backbone of railroad business, the freight traffic, now calls for heavier trains and much faster schedules. Railway managers demand this. Expenses are per train-mile and the revenue per ton-mile. How is this demand to be met if the limit has already been reached in the capacity of steam locomotives?"

In the opinion of Mr. Burch the whole question really hinges upon the advisability of incurring the heavy investment for additional equipment. This, however, may not be one which can be evaded. The progress of invention and industry has never been successfully opposed by existing interests, however much it may have been retarded. Old ideas are constantly being replaced by new, and the mistaken conservatism which endeavors to place itself in a false position must inevitably be compelled to recede.

"In the application of electric traction to heavy railway service, the steam railway engineer and the electric railway engineer must work together. Their first work is to get the facts as they exist—to get the actual power required for all classes of service, switching, freight and passenger. The facts regarding average and maximum service require the best judgment. Each possible saving must be detailed, as outlined; in repairs of roadway, repairs and renewals and supplies for locomotives, in wages of engineers, firemen and helpers, and in the shops, in fuel and in many other items which at once suggest themselves. Contrariwise, there will be the interest, depreciation and maintenance of additional equipment, central-power stations with either steam prime movers and boilers (or a dam and turbine), electric generators, transmission lines, transformers and alternating current distribution. Electric traction is clearly an important development in railway engineering, nothing radical being proposed. Its adoption is never warranted, except on a basis of increased economy of operation. The supercession of the steam locomotive by the electric locomotive is primarily a question of profit and loss, and here the proposition stands in favorable light for commercial consideration."

Judgment in Technical Matters.

THE education of the judgment is very properly regarded as very important in all branches of thought and work, and in none is it more valuable than in the work of the engineer. For this reason the thoughtful and original paper of Mr. George W. Dickie, recently presented before the Technical Society of the Pacific Coast, and published in the *Journal* of the Association of Engineering Societies, is of much interest.

Mr. Dickie shows the impossibility of teaching "common sense" in educational in-

stitutions because of the impossibility of finding suitable professors, and is obliged to admit that each individual must acquire this most important portion of his training by practical experience, and with but moderate success in most instances.

The tendency to self-deception is very strong in all men, while at the same time the bias which appears in individual judgments is for the most part honest and unconscious. As a result, there appears to be growing up a system which apparently proposes to dispense with the necessity for the exercise of judgment in dealing with everyday problems in engineering. Young men without experience, who have never had the chance to acquire an educated judgment, are often put in charge of important work, and a set of instructions provided for their guidance, which instructions are supposed, if rightly carried out, to obviate the necessity for any exercise of judgment on the part of the person in charge.

This is especially the case with inspectors appointed to examine work executed by private firms for government and other contracts, and the results in many cases are interesting and peculiar. Instructions, often framed by persons by no means competent to take charge of the work themselves, are required to be followed in an implicit and unreasoning manner by inspectors who, not having proper judgment themselves, are thus prevented from considering the judgment of those who are competent. The general idea is that instructions of this sort are intended to protect the government or other party for whom the work is being done. As a matter of fact there are two parties to every contract, and both are equally entitled to protection, while the real purpose of the instructions should be the production of the best possible piece of work.

Mr. Dickie gives a number of interesting examples of the manner in which test requirements and similar conditions have been enforced to the positive detriment of the product. Thus a welded joint in a boiler was rejected because the metal was one thirty-second of an inch thinner at the seam than required by the specifications, and a riveted joint demanded instead, thus permitting a seam of 67 per cent. of the strength of the plate to be used, and rejecting one giving 92 per cent. The welded work was condemned and thrown away not because of any desire on the part of the inspector or his superior to cause loss to the contractor, but simply from a failure on their part to apply sound judgment to the question.

"A plan or specification is an instrument to be used for the production of a certain piece of engineering work. The thing produced is the only reason for the instrument being brought into existence, and when once the instrument has served its purpose its value disappears.

"Yet engineers engaged to apply this instrument are, as a rule (especially the young men), more intent on applying the instrument than in considering what the instrument may be doing, forgetting that the instrument can of itself produce nothing, and that if not applied with judgment it will produce only such things as the man that made the instrument could himself produce. But, when applied with the correcting power of sound judgment, acquired in the production of similar things with other instruments, it becomes pliable in the hand of a master, and the result is the combined power of the instrument with the trained judgment of him that applies it.

"All technical men engaged in producing tangible things out of ideas expressed in our defective language, interpreted by some one perhaps better acquainted with words than with things, and whose judgment has not been matured by any intimate knowledge of the actual work that the specification he is to enforce is intended to produce, feel how hard it is to get their position understood, and how often they must do things against their better judgment for fear it may be thought that their own interest, and not their experience, is the foundation on which their judgment rests."

The Exhaustion of Nature's Stores.

A RECENT editorial in *Engineering News* sounds the alarm concerning the reckless manner in which mankind is wasting the stores of energy provided by nature, and properly claims that the task before the engineer in the twentieth century is that of facing and solving this great problem. This is considered to be more especially

the case because the past century has been the one in which the reckless use of nature's stores really began.

"When future generations look back upon the nineteenth century, whose work we now regard with such pride, it is quite possible that their chief sensation will be wonder at the profligate waste that characterized the people who first made large use of the earth's stored-up riches.

"We shall not be far from the truth if we say that, until the nineteenth century, mankind was content to live off the annual produce of the earth. A trifling use was made, indeed, of the fuels and metals and minerals stored beneath the soil, but it was a mere nothing compared with the drafts which the closing years of the nineteenth century have made. A moment's thought will show the truth of this statement. Take our most used mineral, coal. When the nineteenth century began, the railways and steamships, which now make such enormous drafts on the world's coal seams, were undreamed of. The stationary steam engine had had its beginning, but its use was still so limited that it cut no figure at all in the world's coal consumption. The principal use of coal was for household fires and for the crude metallurgy of the day, and this only in countries like England, where the removal of the forest growth had caused a scarcity of wood and of its product, charcoal.

"With no railways, no steamships, no factories and mills, the consumption of metals was almost as trifling as that of coal. Not until the nineteenth century, and indeed not until the last two-thirds of that century, did mankind begin to make any appreciable drafts upon the treasures laid up in nature's storehouses.

"For the last 50 or 75 years, however, the use of these stored materials has been prodigious. Each year sees an increase in the consumption of all the things which the earth yields; and we are accustomed to point to this growth as evidence of the world's advancement in civilization. Is it not time to ask ourselves whither all this is tending?"

Assuming that the demand for energy in some form is bound to increase in an accelerated ratio during the century just begun, it is worth while to discuss the practical means by which not only current demands may be met, but future sources indicated, and this is indeed the work of the engineer in the broadest sense of the term. Taking up the various requirements of mankind in turn, the article referred to proceeds to show how food supplies, structural materials, fuel supplies, precious metals, all are being exploited, not only to an enormous extent, but also in a most wasteful manner.

While this exhortation to greater economy and abstention from waste is timely and thoughtful, yet at the same time there are some points about it which will bear further study and thought.

Considering first of all the vital question of food supply, the doctrine of Malthus, concerning the rate at which population was overtaking subsistence, was first brought to public notice in 1798, and so brought that subject to attention at the beginning of the last century. The theory, as it was epigrammatically put at a much later date, consisted in the statement that "the world would some day wake up to find that the last possible breakfast had been eaten the day before."

As a matter of fact, certain laws have since been discovered which bear somewhat upon the subject. We now know that matter and energy are both indestructible, and that the elements of which subsistence is composed must always exist in undiminished quantity. That the slow processes of nature in the conversion of inorganic material into organic and sustaining compounds may not be equal to future demands may indeed be true, but it does not follow that food products may not hereafter be made in the laboratory on a huge commercial scale, at a rate commensurate with all requirements. Certain it is that the material for such synthetic technical chemistry cannot be lacking, and it is only the methods which need to be developed. If chemistry is to be held responsible for the restoration to the soil of the elements needed to maintain vegetation, why not go a step further, and conduct the entire work in the rapid laboratory rather than in the slow field? The exhaustion of fuel supply has already pointed out the necessity of utilizing other sources of energy for mechanical purposes. Of such sources there is no lack.

Already electrical transmission has caused a return to water power to become practically commercially possible. Add to this the utilization of solar heat, of the internal heat of the earth, and of the energy of the waves and tides, and we have sufficient for all future purposes; supplies not stored in the past and subject to exhaustion, but generated continually, or rather derived from that one great source, the sun. When that source begins to fail, the demand will fail with it, and human life will be exhausted long before its supply of solar energy is gone.

So far as the supply of materials of construction is concerned there is little need for alarm. The metals already extracted from the earth can be supplemented by other whose reduction has only become possible by recent methods. Aluminum will doubtless become of increasing utility as its production is facilitated, and the supply is practically unlimited. Artificial stone will replace the natural article and will possess the advantage of greater ease of preparation. Other artificial materials will doubtless be evolved to supply the demand, and as the absolute destruction of matter is impossible, so the supply of material for conversion remains constant, and only the method of conversion enters into the problem.

It is by no means intended that this view of the situation should weaken the warning conveyed in the article referred to, so far as urging the reduction of waste is concerned. One of the fundamental principles of good engineering is the prevention of waste. The term "by-product" has no real right to existence, as all products should be equally important and none should be permitted to go to waste. The development of processes of direct utilization of natural energy, and the synthetic production of substances now obtainable only through the slow processes of nature, must necessarily take time, and the transition must be gradual and tentative. The work of the engineer in the new century must be devoted both to the reduction of wastes in existing methods and to the production of new and better methods which shall be, so-to-speak, "endless chains," having for the basis of their action the fact that both matter and energy are indestructible, and that nothing is ever lost or useless.

Engineering and Architecture.

A RECENT editorial in the *Iron Age* calls attention to the manner in which the function of the architect is disappearing, as that of the engineer becomes more and more important, in the evolution of modern building. Formerly the architect made the entire designs, not only of the visible portions of a structure, but also of its constructive details, and in addition superintended its actual construction. With the recorded experience of ages at his disposal he was able to adapt or invent, as taste and circumstances demanded, and the experience of the builders who actually executed his work made matters comparatively simple.

To-day it is difficult to say wherein the true function of the architect in a modern building exists. The limitations of construction give little opportunity to exercise the artistic side of the work formerly so fully elaborated, while the construction must necessarily fall to the portion of specialists. Foundations require the most skilful work of the civil engineer. Structural work involves mechanical engineering in combination with a knowledge of manufacturing conditions. Elevators, lighting, etc., fall to the share of the electrical engineers, while a modern office building or hotel contains more of the work of the sanitary engineer than many a town fifty years ago.

At the present time the architect assumes the general direction of the whole work, while the actual planning and execution must be performed by specialists in each department of work, and as these departments are almost altogether engineering in their nature it seems not at all unlikely, as the *Iron Age* puts it, that the function of the architect may, before long, "be eliminated altogether by the engineer, who will assume the baton, and, when he needs him, employ an artist to design his ornamentation."

The Progress of Aluminum.

IN a review of the position of aluminum at the Paris Exposition of 1900 presented to the Franklin Institute by Professor Joseph W. Richards, and published in the *Journal* of the Institute, there is told a story of development in a branch of applied science almost without a parallel.

At the Paris Exposition of 1855 there was

shown a small bar, costing probably more than its weight in gold, and representing only a laboratory curiosity. By 1867, Deville had perfected the sodium process, and many exhibits of a practical character were seen. The production reached about one metric ton per year, and the cost was about $12 a pound. But moderate progress appeared at the next Exposition in 1878. The price had not been reduced, and the applications were necessarily limited. In 1889, however, a revolution in the industry was apparent. The improvements of Castner and Netto in the manufacture of sodium at a greatly reduced cost, made a corresponding reduction possible in the cost of aluminum, the selling price falling to $5 per pound, while the electric processes of Cowles and of Heroult enabled aluminum alloys to be produced at even lower prices.

"The last year of the century finds the industry upon an entirely different basis. From an annual production of 70 tons it has risen to the relatively enormous figure of 7,000 tons; from a price nearly $5 a pound, to the almost incredible figure of 30 cents. The seeds of this revolution were already germinating in 1889, for in that year pure aluminum made electrolytically by Hall in America, and Heroult in Europe, began to undersell the product of the sodium processes, and two years later the sodium processes were distanced and driven out of the business. The pure aluminum shown in 1889 was all made by the sodium process; that shown this year was as exclusively electrolytically produced.

"It is almost needless to say that this decrease of price to less than one-tenth of its value in 1889 has been the prime cause of the great demand for the metal. Every decrease in price has opened up the way for larger and novel uses. Many an experimenter has reported of aluminum: 'It is most admirably adapted for this purpose, and *when its price shall have been reduced,* etc., etc.,' and has waked up a year or so later to the fact that his hoped-for reduction of price had occurred, and that the application he had discovered was then possible. The same is true now, as then; possible uses for large quantities of aluminum are now known, which the probable reduction in price during the next five or ten years will convert into actual uses.

"Such being the present facts with regard to output, prices and applications, we can state with exactness that the aluminum industry is now, at the end of the century, upon a strictly normal commercial basis. Aluminum is now as really a metal of every day life as silver, nickel, mercury, copper, brass, tin, zinc, lead or iron, though not to the same degree as several mentioned. In the United States, in 1898, only pig iron, copper, lead and zinc were produced in greater quantity than aluminum, and only pig iron, copper, lead, zinc, silver and gold surpassed it in value of output. Nickel, mercury, antimony, bismuth and tin were all surpassed. When we wish to make a given object in metal, it can be made cheaper in aluminum than in anything else, excepting zinc, lead or iron; brass, copper, and all the other metals are dearer."

The firms now producing aluminum are the Pittsburg Reduction Company, Niagara Falls; the Cowles Electric Smelting and Aluminum Company, Niagara Falls; the British Aluminum Company, at Foyers, Scotland; the Aluminium Industrie Actien Gesellschaft, at Neuhausen, Switzerland; the Société Electrometallurgique Française, at La Praz, Savoy; the Société Industrielle de l'Aluminium, at St. Michel, Savoy. This year will also see put into operation a new plant of the Pittsburg Reduction Company on the St. Lawrence River, Canada, and two new plants of the Neuhausen Company, one on the Rhine at Rheinfelden, Germany, the other at Lend-Gastein near Salzburg, in Austria. The establishments already in operation have capacity of 34,000 horse-power, capable of producing 7,000 tons of aluminum a year; with the additions referred to, the totals will be 47,000 horse-power, and 10,000 tons annual capacity.

Electricity on the Manhattan Elevated Railway.

A RECENT issue of the *Street Railway Journal* is devoted in great part to the plans and work for the conversion of the elevated railway system of New York from steam locomotive traction to electric power. The undertaking is so extensive, and this account is so exhaustive that little more can be done here than to call attention to the article and make some general comments.

The apparent tardiness of the administra-

tion in delaying the adoption of what seems the ideal motive power for such a road is explained by the wisdom which permitted other roads in other cities do the experimenting, and thus render it possible for New York to secure the best and latest equipment possible. Doubtless this was wise from one point of view, but this argument carried to its logical conclusion would, if applied throughout the United States, have caused electric traction to be as far behind there as it was a year or two ago in the rest of the world. However that may be, the work is now well advanced, and will doubtless be most successful, it being expected to have the engines turning in the power house by June 1, of the present year.

The magnitude of the undertaking will be realized when it is understood that the main power station is expected to be capable of generating 100,000 horse power, and this energy is to be distributed to 200 moving trains on the elevated railway with certainty and satisfaction. New York is dependent in great part upon this system of lines for the transportation of the greater part of its active population in the course of daily work and any interruption of the service would entail a loss of time amounting to a great public disaster. An example of what the problem involves is found in the figures given below. Thus, on one day in 1899, the Sixth and Ninth Avenue divisions alone carried 490,000 passengers, while on two consecutive days last year all of the lines carried 1,700,000 passengers. During the heaviest period of traffic, 140 trains, or 640 cars, per hour, were run on the western division, and 280 trains, or 1,280, on the entire system. The grand total for the twenty-four hours was 4,828 trains, which made 43,853 train miles, and 21,984 cars, which made 198,399 car miles. The record traffic figure of the system for twenty-four hours was made in 1892, when 1,075,000 passengers were carried in one day. In the entire history of the railway company, during which it has carried over three and a third billion passengers, it has never killed a passenger in an accident to a train. In view of the excellent management, by which these results have been secured with steam locomotives, it is not too much to expect that with far better electric equipment, the traffic of the company will increase in a manner which will make the present figures seem insignificant.

The completion of the conversion of this remarkable service from steam to electric traction will form undoubtedly the greatest electric and power installation, with the exception of Niagara, yet attempted, and the detailed account as given in the collection of articles above referred to is a most complete story of a great engineering feat.

Moulding by Machinery.

THE introduction of machine moulding is a matter under consideration in many foundries on both sides of the Atlantic at the present time, and hence the paper recently read before the Foundrymen's Association by Mr. I. L. McCord and published in the *Foundry* is very timely.

The work of moulding may be analyzed into five principal operations, viz.:

1. Getting the flask, pattern and match board together and putting in the sand.
2. Ramming or compressing the sand.
3. Removing the pattern from the sand.
4. Placing the mould on the floor.
5. Pouring the melted iron into the moulds.

Of course in addition to these five operations is the riddling of sand, the application of facing to the moulds, shaking out, etc., which for the present we will assume to be practically the same, whether the moulds are made by hand or on machine.

It is principally for the purpose of reducing the cost of the five operations mentioned that moulding machines have been invented, and it is obvious that the machine which will effect the greatest saving in the aggregate during these entire five operations is the most desirable machine, quality of work, of course, duly considered.

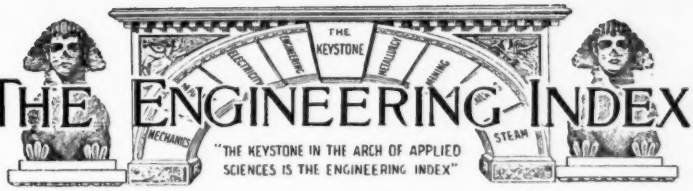
It is a comparatively easy problem to devise a machine which will effect a saving in one or two of these five operations. For example, on certain classes of light work patterns may be attached to metal match plates, so that they are at all times together in convenient form to set into the flasks, which may be stacked near at hand, and thus effect a saving in the first operation. Again, a machine can be readily constructed so that, regardless of the other operations, it will effect a saving in the second operation, that of

ramming the sand. Likewise stripping plates facilitate the removal of the patterns from the sand. The moulds may also be conveyed in some manner direct from the moulder to the cupola for pouring, and a saving thus effected in operations four and five. But to effect a saving at one point without increasing the cost at some other point is the perplexing question.

Many makers of moulding machines believe that the greatest saving can be effected by ramming the sand automatically and rearranging the remaining operations to accommodate a machine for power ramming. Where the ramming is the principal part of the work this position is doubtless correct, but there are other considerations. Mr. McCord gives many instances of the advantages of the stripping plate machines, showing that very often a greater output, all things being considered, can be attained by the use of simple hand-ramming stripping-plate machines, taking into account the extra handling of sand and flasks.

In discussing the general advantages of moulding machines, Mr. McCord concludes as follows:

"There are many questions that have been discussed in connection with moulding machines, such as the division of labor—that is, having one force of men operate the machine all day, and another gang do the pouring. We believe these are matters that can best be adjusted by foundries individually. In many instances it is no doubt more economical to have a separate gang of men for pouring. In most cases, however, where you are trying to get along with laborers for moulding, we think it a good plan to have them pour their own work. There are not so many men to educate, and besides the relief from the monotony of moulding on the machine is a good thing for the men. They will feel themselves capable of doing more than one thing and will take more interest in their work. The fact that they may sit around a few minutes after the blast goes on is not going to count against them. They will not do one whit more work in a day without that little rest than with it. There are some progressive factories in other lines of business that give their employees 15 minutes' recess both in the forenoon and the afternoon, which takes a half hour out of their working day, but they consider it a good investment. And I do not believe any foundry will lose money by allowing their moulders a short 'breathing spell' from the time the blast is put on until they get their iron."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.

Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.

California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimneys.

A 360-Foot Single-Shell Chimney. Illustrated description of a stack 360 ft. high and 10 to 20 ft. in diameter inside, built of radial perforated brick. 700 w. Eng Rec—Jan. 26, 1901. No. 39013.

The Building and Repairing of Tall Chimneys. Illustrates and describes methods of accomplishing difficult work. 1200 w. Sci Am—Jan. 12, 1901. No. 38643.

Exposition Building.

The Agricultural Building at the Pan-American Exposition. Illustrated description of the wooden framing of a 500 x 150 ft. exhibition building; the details of the carpenter work are fully explained. 1200 w. Eng Rec—Jan. 12, 1901. No. 38765.

Hospitals.

Hospital Construction from a Medical Standpoint. Henry M. Hurd. Considers the arrangement of buildings, heating and ventilation, precautions against fire, floors, walls, etc. 4000 w. Br Build—Dec., 1900. No. 38501 D.

Sanitary Construction.

Some Sanitary Aspects of House Construction. William Wallace. Read before the Congress of the San. Inst., at Glasgow. Discusses points in construction essential in securing pure, dry air for buildings. 2800 w. Dom Engng—Jan. 15, 1901. No. 38820 C.

Waterproofing.

Waterproofing the Basement of the Government Printing Office Building. John S. Sewell. A description of the tile drains and waterproofing courses at this large structure. 800 w. Eng Rec—Jan. 12, 1901. No. 38764.

HEATING AND VENTILATION.

Combination Systems.

Proportioning Hot-Water Radiation in Combination Systems of Hot Air and Hot Water Heating. R. C. Carpenter. Read at meeting of Am. Soc. of Heat. & Ven. Engs. Gives results of some experiments in proportioning heating surface in a hot air furnace to hot water radiation and an accurate test of the efficiency of the different parts of a furnace and combined with a hot water heater. 2500 w. Met Work—Jan. 26, 1901. No. 38875.

Forced Ventilation.

Mechanical Ventilation and Heating by a Forced Circulation of Warm Air. Walter B. Snow. Gives an illustrated description of this combined system, stating its advantages, and showing its adaptation to various types of buildings. 4800 w. Jour Worcester Poly Inst—Jan., 1901. No. 38860 C.

Heating.

Heating Apparatus at the Exposition of 1900 (Les Appareils de Chauffage à l'Exposition de 1900). F. Dommer. The first of a series of articles reviewing the warming apparatus shown, including steam, hot water, hot air, and isolated heating. Serial. Part I. 1500 w. Génie Civil—Dec. 15, 1900. No. 38902 D.

Hot Water.

A Low Pressure Hot Water Heating System Receiving Heat from a Steam Boiler. John Gormly. Read at meeting of Am. Soc. of Heat. & Ven. Engs. Illustrates and describes a device containing features of interest. 1000 w. Met Work—Jan. 26, 1901. No. 38873.

Heating of the Westminster Chambers, Boston. Illustrated description of a hot-water heating plant in an 8-story, 104 x 145 ft. apartment house. 1000 w. Eng Rec—Jan. 5, 1901. No. 38570.

Japanese Palace.

Ventilating and Heating the Palace of the Crown Prince of Japan. Illustrated description of a hot blast steam apparatus for warming the main apartments of this palace, direct-radiation for the basement and corridors and a cooling system for use in summer. 3100 w. Eng Rec—Jan. 19, 1901. No. 38792.

Standardisation.

Report of Committee on Standards. Code for Testing Direct Radiation Heating Plants. Report presented at N. Y. meeting of the Am. Soc. of Heat. & Ven. Engs. 3400 w. Met Work—Jan. 26, 1901. No. 38874.

Station Heating.

Central Station Heating. Illustrated abstract of paper by William H. Bryan, presented at meeting of Am. Soc. of Heat. & Ven. Engs., on the financial features of public steam and hot-water heating service by electric companies. 3300 w. Eng Rec—Jan. 26, 1901. No. 39017.

Steam Heating.

Low-Pressure Steam Heating in France. Gustave Debesson. Illustrated extracts from a paper presented to the Am. Soc. of Heat. & Ven. Engs., describing typical French gravity systems, with special radiator valves and copper pipe joints. 1200 w. Eng Rec—Jan. 26, 1901. No. 39018.

Ventilation.

Natural Ventilation (Ueber Natürliche Lüftung). W. Mehl. An examination of the manner in which air becomes fouled, and of the best method of inducing currents to provide for the necessary change by natural means. Two articles, 1 plate. 7500 w. Gesundheits Ingenieur—Dec. 15, 31, 1900. No. 38948 each B.

Vitiated Air.

The Air of Buildings and Sewers. J. S. Haldane. Read at the Bolton Congress of the San. Inst. of Gt. Britain. Gives results of recent experimental researches and the conclusions reached. 3600 w. Dom Engng—Jan. 15, 1901. Serial. 1st part. No. 38819 C.

PLUMBING AND GAS FITTING.

Fittings.

Sanitary Fittings and Plumbing. The introduction to a series of articles discussing modern practice. 2000 w. Builder—Jan. 5, 1901. Serial. 1st part. No. 38712 A.

CIVIL ENGINEERING

BRIDGES.

Bridge Practice.

Three Questions Respecting Bridge Practice. Edward Godfrey. States three questions for discussion, giving personal views. 900 w. Eng News—Jan. 24, 1901. No. 39004.

Bridge Shop.

See Mechanical Engineering. Machine Works and Foundries.

Drawbridges.

Competitive Designs for the 95th St. Bascule Bridge Over the Calumet River, Chicago. Illustrated description of accepted and submitted designs. 4800 w. Eng News—Jan. 10, 1901. No. 38646.

New Systems of Drawbridges in America (Neuere Systeme Beweglicher Brücken in den Vereinigten Staaten von America). Describing the Harman, Schinke, and Scherzer systems of drawbridges. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 21, 1900. No. 38932 B.

Permanence.

The Permanence of Iron and Steel Structures. An editorial on the possibility of preserving inaccessible parts of a bridge structure by embedding them in cement. 1000 w. Eng Rec—Jan. 5, 1901. No. 38564.

Renewal.

Driving Difficult Piles for a Bridge Renewal. Describes method of building bents across a long railway bridge without interrupting traffic. 600 w. Eng Rec—Jan. 19, 1901. No. 38790.

Rouen.

The Hanging Bridge at Rouen (Die Ueberfuhrbrücke in Rouen). H. Franz. An illustrated account of the high-level suspension bridge, with low-level hanging transport platform recently erected at Rouen. 1500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1901. No. 38946 D.

Swing-Bridges.

Converting a Fixed Bridge Span Into a Swing Span. Illustrates and describes an interesting piece of work on the Pere Marquette R. R. at New Richmond, Mich., carried out without interrupting traffic. 600 w. Eng News—Jan. 17, 1901. No. 38783.

The Charlestown Swing Bridge, Boston, Mass. Illustrated description of a recently completed bridge, particularly remarkable for its width of 100 ft., which is continuous over the swing span, for being a double-deck structure throughout, and for the heavy and solid character of its substructive and foundation work. 2500 w. Eng News—Jan. 24, 1901. No. 39002.

Viaduct.

The Gokteik Viaduct, Burmah. Illustrated description of a steel viaduct 2,260 ft. long and 320 ft. in maximum height. The general features of the structure and its erection are explained. 2300 w. Eng Rec—Jan. 12, 1901. Serial. 1st part. No. 38760.

The Kinzua Viaduct of the Erie Railroad Company. George S. Morison, R. S. Buck and L. S. Moisseiff. Discussion of paper by C. R. Grimm. 5500 w. Pro Am Soc of Civ Engs—Jan., 1901. No. 38885 E.

CONSTRUCTION.

Columns.

The Practical Column Under Central or Eccentric Loads. Albert I. Frye. Continued discussion of paper by J. M. Moncrieff. 500 w. Pro Am Soc of Civ Engs—Jan., 1901. No. 38884 E.

Dry Dock.

Additional Particulars of the Floating Dry Dock for Algiers, La. Particulars and details of the construction. Ill. 2000 w. Marine Engng—Jan., 1901. No. 38693 C.

Fire-proofing.

The New York Fire Insurance Exchange Schedule. Discusses some features of this

schedule. 1000 w. Br Build—Dec., 1900. No. 38502 D.

Foundations.

On the Use of Monier Pipes as a Pipe Covering, and in Place of Cast Iron for Cylinder Foundations. Ernest Macartney de Burgh. An illustrated article favoring the use of pipes constructed on the Monier principle, to protect pipes from attacks of the Teredo navalis. 1400 w. Prac Engr—Jan. 4, 1901. No. 38707 A.

Graphostatics.

Framed Structures Examined by Graphical Statics (Beweis Einiger Konstruktionen mit Hülfe der Graphichen Statik). M. Kinkel. Giving the application of graphical statics to certain forms of curved trusses. 1200 w. Schweizerische Bauzeitung—Jan. 12, 1901. No. 38941 B.

Hinged Arch.

The Pointed Arch with Free Hinged Springings (Der Spitzbogenträger mit Frei Drehbaren Kämpfergelenken). Adolf Francke. A mathematical investigation of the forces in hinged Gothic arches of various forms and loadings. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 28, 1900. No. 38933 B.

Piers.

The New Fireproof Piers of the North German Lloyd Steamship Co., at Hoboken, N. J. Illustrated detailed description of important fireproof construction, with editorial. 5500 w. Eng News—Jan. 3, 1901. No. 38549.

Retaining Walls.

Masonry Dams and Retaining Walls in General, Concrete Works, etc. Charles Baillairge. Remarks on retaining walls in Quebec, their failures and rebuilding. Also considers stone or masonry dams, concrete dams, and curved or bowed dams. 6800 w. Can Soc of Civ Engs—Adv. Proof—Jan. 3, 1901. No. 38624 D.

Roads.

Facts and Fallacies Concerning Good Roads. Letter from Martin Dodge, replying to criticisms of the Road Inquiry Bureau's statistics, with editorial. 6000 w. Eng News—Jan. 17, 1901. No. 38785.

Progress of Road Building in the United States. Maurice O. Eldridge. A review of the early roads of the country, and of the progress made in various parts of the country. 3000 w. Brick—Jan. 1, 1901. No. 38577.

The New Jersey State Road System. William L. Dickinson. A description of the results of the New Jersey State road law. 1800 w. Eng Rec—Jan. 19, 1901. No. 38791.

Tunneling.

Section Third of the New York Rapid Transit Subway. Illustrated description of a four-track subway in an important New York street, built by the cut and cover method, without disturbing four street railway tracks. 2500 w. Eng Rec—Jan. 12, 1901. No. 38763.

The Cascade Tunnel, Great Northern Ry. John F. Stevens. The crossing of the summit of the Cascades has been effected by means of a switchback. A long tunnel has now been completed which will do away with this switchback. The methods of construction are illustrated and described. 3800 w. Eng News—Jan. 10, 1901. No. 38647.

The Construction of Railroad Tunnels. J. V. Davies. Reviews the various methods of underground construction of tunnels and subways. Illustrations and general discussion. 12000 w. N Y R R Club—Dec. 20, 1900. No. 38698.

The Hastings Tunnel Shield, Chicago Intercepting Sewers. A description, by the City Engineering Department of Chicago, of two shields, 25 ft. in diameter, used in clay. 1400 w. Eng Rec—Jan. 19, 1901. No. 38789.

Tunneling Through Fine Sand. Illustrated description of a method of driving a heading for a 6½ ft. sewer by canvas backing for the lagging and cantilever supports for the top poling boards. 1200 w. Eng Rec—Jan. 26, 1901. No. 39011.

HYDRAULIC AND MARINE.

Canals.

Design for Controlling Works at the Head of the Chicago Drainage Canal. Abstract of a paper read by Ossian Guthrie before the W. Soc. of Engs. Illustrated description of proposed works, consisting of a lock the full width of the canal, subdivided by a central wall, the left-hand channel being a by-pass and the right-hand channel a lock. 2500 w. Eng News—Jan. 3, 1900. No. 38547.

Internal Waterways at the Paris Exposition (Die Binnenschiffahrts-Canäle auf der Pariser Weltausstellung 1900). Richard Kuhn. A review of the internal waterways of various countries as illustrated by exhibits at Paris. 5000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1901. No. 38947 D.

Russia's System of Internal Waterways. A. H. Ford. In the first of an important series of papers on the development of Russia the question of the importance of transport as an element in the expansion of manufactures and trade is discussed. 3500 w. Engineering Magazine—Feb., 1901. No. 38974 B.

The Engineering Works of the Suez Canal. Condensation of a report to the Inst. C. E. by Sir Charles Hartley, being the first complete report in English. 5000 w. Eng Rec—Jan. 5, 1901. No. 38571.

The Nicaragua Canal Question and the Clayton-Bulwer Treaty. Robert Brom-

ley. A discussion of the Hepburn Bill, the Clayton-Bulwer Treaty, and international matters relating to the construction of this canal. 7300 w. Nineteenth Cent—Jan., 1901. No. 38794 D.

Docks.

The River Ribble and Preston Dock. A review of the Commissioner's Report and of the recent report of the resident engineer, Mr. A. F. Fowler, concerning the work accomplished. 2200 w. Engr, Lond—Jan. 18, 1901. No. 39032 A.

Dredges.

Dredges for the New 40-Foot Channels of New York Harbor. Describes the work proposed, giving map, and gives illustrated description of the dredge "Thomas," specially constructed for this work. 1400 w. Sci Am—Jan. 12, 1901. No. 38644.

The Bates Hydraulic Dredger. An illustrated description of a dredger for the port of Rockhampton, Queensland. 2000 w. Engng—Jan. 11, 1901. No. 38833 A.

Filtration.

A Proposed New System of Mechanical Filtration for Louisville, Ky. Describes a new system developed by Charles Hermany. Ill. 1500 w. Eng News—Jan. 17, 1901. No. 38787.

Covers for Slow Sand Water Filters. Allen Hazen. From a report to the Trenton Water Board on "Pollution and Filtration of the Delaware River Water Supply for the City of Trenton, N. J." Discusses points to be considered in deciding whether or not to cover filters, with the writer's reasons for recommending open filters. 4500 w. Eng News—Jan. 24, 1901. No. 39001.

Filtration and Meterage at Norfolk, Va. Illustrates and describes the plant, giving information also of the supply, waste, etc. 1800 w. Fire & Water—Jan. 5, 1901. No. 38639.

Notes on Designing and Constructing Slow Sand Filters. James H. Fuertes. A discussion of the method of estimating the total area of filters and the size of the individual beds. 2000 w. Eng Rec—Jan. 26, 1901. Serial. 1st part. No. 39012.

The Mechanical System of Water Filtration. Floyd Davis. Describes the filters and their operation. 1000 w. Munic Engng—Jan., 1001. No. 38481 C.

Ground Water.

The Ground-Water Supply for Sternberg and Witkowitz, in Moravia (Gewinnung des Grundwassers für die Wasserversorgung von Sternberg und Witkowitz in Mähren). Prof. A. Oelwein. With topographical maps of the territory, and sections of the wells and filters. 3000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 14, 1900. No. 38931 B.

Harbors.

An Internal Harbor System for Chicago. Albert H. Scherzer. Suggests a plan for maintaining and extending the railroad and water transportation interests, showing its advantages, and giving outline maps. Also editorial. 2500 w. Ry Age—Jan. 11, 1901. No. 38755.

The Ports of Tunis (Les Ports Tunisiens). G. Leugny. Especially describing the harbor of Bizerte, and the recent improvements. 3000 w. Revue Technique—Jan. 10, 1901. No. 38913 D.

Harbors and Waterways in the Nineteenth Century. Reviews the progress in Great Britain, and the great improvements made. 6000 w. Engr, Lond—Jan. 4, 1901. No. 38734 A.

Irrigation.

Irrigation Farming in the Southwest. D. Allen Willey. Describes methods of irrigation in Louisiana, for the cultivation of rice. Ill. 1500 w. Sci Am—Jan. 26, 1901. No. 38869.

Irrigation in the Hawaiian Islands. Wade Warren Thayer. Illustrated description of an engineering feat which brings a supply of 50,000,000 gallons of water daily, a distance of 22 miles, through a very difficult region. 700 w. Sci Am—Jan. 12, 1901. No. 38642.

Lake Nicaragua.

The Water Supply of Lake Nicaragua. Angelo Heilprin. A reply to criticisms by the hydrographer of the Nicaragua Canal Commission. 1700 w. Sci Am Sup—Jan. 12, 1901. No. 38645.

Progress.

A Century's Progress. A review of the progress made during the last century in hydraulic and sanitary engineering. 2000 w. Fire & Water—Jan. 5, 1901. Serial. 1st part. No. 38640.

Pumping.

Duluth's Municipal Pumping Plant. Illustrates and describes the pumping engines of this plant. 800 w. Power—Jan., 1901. No. 38641.

Reading, Pa.

Reading and Its Reservoirs. Illustrates and describes the present water-works system, and the difficulties encountered because of the city being built on a slope. 1000 w. Fire & Water—Jan. 26, 1901. No. 39045.

River Improvements.

Improvements at the Mouth of the Yazoo River. Brief account of the work in progress for the improvement of the harbor of Vicksburg, and of navigation on the Yazoo River. Maps and Ill. 900 w. Ry & Engng Rev—Jan. 26, 1901. No. 39046.

The Artificial Feeding of the Neste

(L'Alimentation Artificielle de la Neste). P. Frick. An account of the manner in which some lakes of the Pyrenees have been tapped to supply an agricultural district. 2000 w. Génie Civil—Jan. 12, 1901. No. 38907 D.

The Extended Navigation on the Monongahela River. F. L. Emory. Briefly reviews the history of locks and dams for river improvement, and gives an account of the proposed work on the river named. 3400 w. Jour Worcester Poly Inst—Jan., 1901. No. 38858 C.

The Improvement of the Illinois and Des Plaines Rivers. Extracts from a report by U. S. engineer officers against the extension of deep water navigation from the Chicago drainage canal to the Mississippi, unless Congress authorizes a corresponding improvement of that river. 1800 w. Eng Rec—Jan. 5, 1901. No. 38565.

Stand-Pipes.

Deterioration of the Peoria Stand-Pipes. Dabney H. Maury. Reply to a review by Albert B. Herrick of a paper by the writer on "Electrolysis of Underground Metal Structures." Also a note from A. A. Knudson. Ill. 2800 w. Eng News—Jan. 24, 1901. No. 39005.

Water Analysis.

Permanent Standards for Use in the Analysis of Water. Daniel D. Jackson. Describes the permanent standards already employed, and considers in detail the new standards proposed. 3500 w. Tech Quar—Dec., 1900. No. 38771 E.

The Evolution of the Oxygen Absorption Test in Water and Sewage Analysis. J. W. Weems. Extract from a paper before the Iowa Engng Soc. Historical sketch, giving the scheme of each test of this nature and an explanation of the proper interpretation of the results of these tests. 1200 w. Eng Rec—Jan. 26, 1901. Serial. 1st part. No. 39015.

Water Meters.

Testing Large Water Meters. Lewis H. Nash. Illustrated description of the apparatus used. 800 w. Stevens Ind—Jan., 1901. No. 38890 D.

Water-Power.

A Wonderful Water Power. F. E. Santos. Illustrated description of the springs of Fossil Creek, Arizona. 800 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38877.

Water Purification.

Water Purification in Louisville. Part first gives an illustrated description of the construction of concrete clear-water basins and concrete-steel vaulting. 1800 w. Eng Rec—Jan. 5, 1901. Serial. 1st part. No. 38567.

Water Supply.

Protection of Underground Water Supplies. W. Matthews. Read at meeting of the British Assn. of Water-Works Engs. Discusses British law for the protection of water supplies, and describes cases that have come under the writer's notice. General discussion. 4200 w. Jour Gas Lgt—Dec. 25, 1900. No. 38603 A.

Public Water Supplies. George R. Perry. From a paper before the Charleston convention of the League of Am. Munic. A discussion of waste, unrestricted use, meters, etc. 2200 w. Munic Engng—Jan., 1901. No. 38484 C.

The Future of the London Water Supply. R. E. Middleton. Read before the Surveyor's Inst., England. States the estimated population to be provided for, the amount of water to be afforded, the sources, etc. 8000 w. Jour Gas Lgt—Dec. 25, 1900. No. 38604 A.

Water Supply. Editorial on the wonderful progress of the nineteenth century; the review is confined principaily to Great Britain. 2500 w. Engr, Lond—Jan. 4, 1901. No. 38743 A.

Water-Works.

The Babylon Water Supply Plant. Illustrated description of works in which water is pumped from wells into four tanks where an air pressure of 45 lbs. is maintained, as a substitute for the head furnished by a water tower. The compressed air is drawn from tanks through regulating valves, maintaining a constant pressure on the water, without regard to the pressure in the air tanks. 1000 w. Eng Rec—Jan. 12, 1901. No. 38761.

The Hartford Vitrified Water Conduit. W. E. Johnson. Abstract of a paper read before the Conn. Soc. of Engs. & Survs. Describes a conduit 16,700 ft. long and 24 in. in diameter, constructed of vitrified clay pipe. The requirements for the pipe and methods of laying it are explained in detail. 1300 w. Eng Rec—Jan. 12, 1901. No. 38762.

The Water-Works Plant of the Pearl River Lumber Co., Brookhaven, Miss. William C. Porter. Describes a well-arranged plant for protection against fire, and for supplying water for uses about a large manufacturing plant. 600 w. Eng News—Jan. 10, 1901. No. 38650.

MATERIALS.

Concrete.

The Concrete Question. William E. Smith. Information relating to the use of concrete by a writer of experience. 1800 w. Ry & Engng Rev—Jan. 26, 1901. No. 39048.

Glazed Bricks.

The Manufacture of Glazed Bricks. F. Walker. Discussing kiln firing, white and colored bricks, clay analyses, etc. 1700 w. Brick—Jan. 1, 1901. Serial. 1st part. No. 38578.

Paving Materials.

Concerning Retene, Petrolene and Asphaltene. S. F. Peckham. A protest against the use of these words, with reasons. 4000 w. Jour Fr Inst—Jan., 1901. No. 38658 D.

MEASUREMENT.

Spirit Leveling.

The Theory and Practice of Precise Spirit Leveling. W. S. Williams, J. A. Ockerson, and C. L. Crandall. Continued discussion of paper by David A. Molitor. 3500 w. Pro Am Soc of Civ Engs—Jan., 1901. No. 38883 E.

Surveying.

Recent Contributions to Our Knowledge of the Earth's Shape and Size, by the United States Coast and Geodetic Survey. C. A. Schott. An account of the work, with chart and explanatory notes. 2200 w. Nat Geog Mag—Jan., 1901. No. 38836 C.

Triangulation.

The Transcontinental Triangulation and the American Arc of the Parallel. John E. McGrath. On the importance of this work and the value of the report, with information relating to the work. 3500 w. Eng News—Jan. 3, 1901. No. 38548.

MUNICIPAL.

Havana.

The Renovation of Havana. An illustrated article considering the street work as given in Col. Black's report. 2500 w. Eng Rec—Jan. 19, 1901. Serial. 1st part. No. 38788.

Pavements.

Repairs to Asphalt Pavements in Buffalo. Extracts from a report by City Engineer F. V. E. Bardol, describing the nature of the failures of asphalt, and methods of preventing and repairing them. 2400 w. Eng Rec—Jan. 5, 1901. No. 38569.

Sanitation.

Sanitary Engineering. Editorial review of progress made during the last year in sewage disposal. 1800 w. Engr, Lond—Jan. 4, 1901. No. 38742 A.

Sewage.

Bacterial Treatment of London Sewage and American Sewage Disposal Problems. Editorial discussion of the report of Dr. Clowes and Dr. Houston, relating to the London experiments. 1800 w. Eng News—Jan. 24, 1901. No. 39003.

Sewage Purification.

The Function of the Septic Tank in Sewage Purification (Ueber Zweck und Bedeutung des Faulraumes bei Abwasserreinigungs-Anlagae). Dr. O. Kröhnke. A general discussion of the septic tank, showing the conditions under which it may be useful. 3500 w. Gesundheits-Ingenieur—Jan. 15, 1901. No. 38949 B.

Sewerage.

Flow in the Sewers of the North Metropolitan Sewerage System of Massachusetts. Theodore Horton. Describes three series of observations made in the channels below the Charlestown and East Boston pumping stations, and the methods used. Ill. 2700 w. Pro Am Soc of Civ Engs—Jan., 1901. No. 38882 E.

New Sewage Works in Paris. Concerning measures in progress for solving the sewage question. 1200 w. Engr, Lond—Jan. 11, 1901. No. 38809 A.

The Sewerage System and Sewage Farm of the Melbourne and Metropolitan Board of Works. Describes this great piece of sewerage work, giving related information regarding cost, connections, and other matters of interest. 3200 w. Eng News—Jan. 24, 1901. No. 39006.

A Sewer Inlet Plan. H. M. Miles. Illustrates and describes the construction of highly satisfactory catch-basins, easily kept clean. 700 w. Munic Engng—Jan., 1901. No. 38483 C.

Vienna.

Project for a Jubilee Place in Vienna (Project zur Schaffung eines Kaiser Franz Josef Jubiläums platzes in Wien). A. Lotz. With plans showing the possibility of making many street improvements in Vienna and the creation of a place in commemoration of the Jubilee of the Emperor Francis Joseph. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 11, 1901. No. 38934 B.

MISCELLANY.

Address.

The Evolution of Science (L'Evolution de la Science à Travers les Siècles). Maurice Levy. The annual address of the President of the Académie des Sciences of France, reviewing the progress of science in past centuries. 6000 w. Comptes Rendus—Dec. 17, 1900. No. 38950 D.

Education.

On the Need of the Education of the Judgment in Dealing with Technical Matters. George W. Dickie. Calls attention to the lack of sound judgment exhibited in dealing with engineering problems. 2700 w. Jour Assn of Engng Socs—Dec., 1900. No. 38822 C.

The Present Problem in Technical Education. Editorial, discussing the need of scientific instruction less extended in scope than that given in technical schools. 1400 w. Eng Rec—Jan 26, 1901. No. 39010.

Review.

Civil Engineering. Editorial review of the nineteenth century work in this field, and noting the more prominent results. 4600 w. Engr, Lond—Jan. 4, 1901. No. 38739 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Ocean Cables Should Be of American Make. J. W. Marsh. Discusses the subject of cables and their manufacture, urging the extension of the industry in the United States. 4500 w. Am Mfr—Jan. 10, 1901. No. 38756.

The Influence of Submarine Cables Upon Military and Naval Supremacy. George O. Squier. Showing the importance of submarine cables in national defence, and discussing the existing and proposed systems of the United States and Gt. Britain. 7500 w. Nat Geog Mag—Jan., 1901. No. 38835 C.

The Outlook for the Submarine Cable Industry in the Twentieth Century. Charles Bright. Considers the outlook better than for some years, and gives views in regard to the Pacific cable proposed. 1500 w. Elec Rev, Lond—Jan. 11, 1901. No. 38797 A.

Independent Telephones.

The Rise, Growth and Present Extent of the Independent Telephone Movement. James M. Thomas. 2700 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38721.

Long Distance.

An Important Telephone Invention Appreciated. Brief account of Dr. Pupin's patents covering the art of ocean telephony, sold to the Bell Co. for a large sum. 1200 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38728.

Dr. Pupin's Improvements in Long-Distance Telephony. Herbert T. Wade. An explanation of Dr. Pupin's investigations and their great success and the application to long-distance telephony and to telegraphy. Ill. 2500 w. Sci Am Sup—Jan. 26, 1901. No. 38872.

Philippines.

Telegraph Operators in the Philippines. F. E. Grain. Information concerning the need of operators and the requirements. 2400 w. Elec Wld & Engr—Jan. 19, 1901. No. 38817.

Printing Telegraph.

A New Page-Printing Telegraph. William B. Vansize. Reviews other work in this field, and gives illustrated detailed description of system invented by Donald Murray. 7000 w. Trans Am Inst of Elec Engs—Jan., 1901. No. 39054 D.

Ship Telegraph.

The Vialet-Chabrand Ship Telegraph (Transmetteur d'Ordres, Système Vialet-Chabrand). G. Dary. An illustrated description of an improved electric dial telegraph for the transmission of orders from the bridge of a vessel to the engine-room. 1800 w. L'Electricien—Dec. 29, 1900. No. 38969 B.

Space Telegraphy.

Determinate and Multiple Spark Telegraphy (Abgestimmte und Mehrfache Funkentelegraphie). Prof. A. Slaby. A review of the writer's experiments, with especial reference to space telegraphy between determinate points. 6000 w. Elektrotech Zeitschr—Jan. 10, 1901. No. 38965 B.

Prof. Slaby's Tunnel and Multiple Spark Telegraphy. Abstract of a lecture delivered before the German Emperor, at Berlin. 1100 w. Elect'n, Lond—Jan. 18, 1901. No. 39000 A.

Some Experiments on the Propagation of Hertzian Waves Along a Wire, and Through the Air. Emile Guarini. An account of experiments made with a simple telephone as a receiver. 2500 w. Elec Rev, Lond—Jan. 11, 1901. Serial. 1st part. No. 38802 A.

Wireless Telegraphy. Arthur V. Abbott. Reviews briefly the discoveries that have made wireless telegraphy possible and its present standing. 2500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38677.

Submarine.

Line-Wave Submarine Cable Telegraphy. A review of a recent paper by Albert C. Crehore and George O. Squier, read before the Am. Inst. of Elec. Engs. Ill. 4000 w. Engng—Jan. 4, 1901. No. 38729 A.

Telegraphy.

The Telegraph. Patrick B. Delany. Historical review. 3600 w. Elec Wld & Engr—Jan. 5, 1901. No. 38681.

The Telegraph in the Nineteenth Century. William Maver, Jr. An interesting review of the history and development, with portraits of S. F. B. Morse and Cyrus W. Field. 4500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38714.

Telephones.

Telephonic Transmission. A discussion of means for increasing the inductance, considering Dr. Pupin's work and results obtained by other investigators. 2000 w. Elec Rev, Lond—Jan. 4, 1901. Serial. 1st part. No. 38701 A.

The History of the Invention and Development of the Speaking Telephone. George C. Maynard. Interesting historical account, with portraits. 5000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38717.

The Railway Telephone. E. A. Chenery.

Discusses the use of telephones in railway work, and thinks a great deal of work now done by telegraph must be done by the telephone. Gives plate of the N. Y., N. H. & H. R. R. telephone systems. 2800 w. St Louis Ry Club—Dec. 14, 1900. No. 38522.

Telephone Exchange.

The Construction of Small Telephone Exchanges. A. E. Dobbs. Gives a copy of a franchise considered fair for the average town, with comments. 2000 w. Elec Rev, N. Y.—Jan. 5, 1901. No. 38552.

The Independent Telephone Exchange at Atlanta, Ga. E. E. Clement. Illustrated description of the main features of a large modern telephone exchange, in which the trunking principle has been successfully used throughout. 2100 w. Am Elect'n—Jan., 1901. No. 38630.

The Multiple Telephone Exchange System of Mix and Genest, for Medium and Small Exchanges (Der Vielfachumschalterbetrieb bei Mittleren und Kleineren Fernsprechämtern nach dem system Mix and Genest). Describing a simplified form of exchange for small telephone systems. 1800 w. Elektrotech Zeitschr—Dec. 20, 1900. No. 38959 B.

Telephonograph.

The Telephonograph (Der Telephonograph). Dr. Rellstab. An examination of the action of the Poulsen telephonograph, showing the condition under which the most accurate records of human speech may be expected. 3000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38968 B.

Telephony.

Telephony. Kempster B. Miller. A review of progress and improvements, noting the present tendencies. 1700 w. Elec Wld & Engr—Jan. 5, 1901. No. 38674.

Telephone vs. Telegraph.

Telephone vs. Telegraph on Railroad Lines. G. F. Jenks. Reviews the reasons why the telephone should not supersede the telegraph. 1000 w. Elec Wld & Engr—Jan. 12, 1901. No. 38684.

Transmission.

The Electrical Transmission of Intelligence. Kempster B. Miller A review of progress made in the telegraph and the telephone. 1700 w. W Elect'n—Jan. 5, 1901. No. 38661.

DISTRIBUTION.

Alternating Currents.

Capacity in Alternate-Current Working. W. M. Mordey. Considers some of the effects of electrostatic capacity in insulated cables for alternate-current working, especially as regards the power and plant. 3700 w. Elect'n, Lond—Jan. 18, 1901. Serial. 1st part. No. 38899 A.

Electrical Oscillations and Electric Waves. J. A. Fleming. Cantor lecture. The first of a series of lectures studying this subject. The present article considers the practical method of producing electrical oscillations, experimental investigations, frequency, etc. Ill. 7800 w. Jour Soc of Arts—Dec. 28, 1900. Serial. 1st part. No. 38605 A.

Alternators.

European Types of High-Tension Alternators. C. F. Guilbert. An account of a careful study made of the alternators exhibited at the Paris Exposition. 2500 w. Elec Wld & Engr—Jan. 19, 1901. No. 38812.

Graphical Treatment of the Effect of Armature Current on Wave Form of Alternator. F. G. Baum. The effect is shown graphically and explained. 600 w. Elec Wld & Engr—Dec. 29, 1900. No. 38497.

Circuits.

The Calculation of Alternating-Current Electro-Magnetic Circuits. Harold B. Smith. Considers circuits in which the magnetic flux is periodically varying in both quantity and direction; hysteresis, eddy or Foucault currents, inductance, etc. Charts. 2200 w. Jour Worcester Poly Inst—Jan., 1901. Serial. 1st part. No. 38859 C.

Conductors.

Aluminum Conductors for Electrical Power Distribution. William Hoopes. Gives data relating to cost, and briefly considers the reliability, durability and maintenance. 1100 w. St Ry Rev—Jan. 15, 1901. No. 38857 C.

The Use of Aluminum as an Electrical Conductor, with New Observations Upon the Durability of Aluminum and Other Metals Under Atmospheric Exposure. John B. C. Kershaw. Abstract of a paper read before the British Inst. of Elec. Engs. 2500 w. Elec Rev, Lond—Jan. 18, 1901. No. 38898 A.

Direct vs. Three-Phase.

Relative Advantages of Direct-Current and Three-Phase Distribution. H. A. Earle. Read at the Manchester Sec. of the Inst. of Elec. Engs. A comparison of the two systems and a consideration of points which should guide in the choice. 4800 w. Elect'n, Lond—Dec. 28, 1900. No. 38601 A.

Lines.

Practical Line Construction. Loren W. Burch. Read at Milwaukee meeting of Northwestern Electrical Assn. Discusses the requirements of good construction. 2000 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38879.

Power Distribution.

The Case for Electric Power Distribu-

tion. W. B. Esson. Read before the Civ. and Mech. Engs. Soc., England. Considers the circumstances upon which must depend the decision as to whether electricity can with advantage displace the older method of power distribution. Also general discussion. 11000 w. Elec Engr, Lond—Jan. 11, 1901. No. 38803 A.

Switchboards.

Central-Station Switchboard Connections. J. A. Seager. Discusses points in the arrangement of high and low-tension connections. 1600 w. Elec Engr, Lond—Jan. 4, 1901. No. 38706 A.

Wiring.

Future Development of Interior Wiring. H. Ward Leonard. Describes the method advocated by the writer, and considers the important requirements. 2800 w. Elec Wld & Engr—Jan. 5, 1901. No. 38680.

ELECTRO-CHEMISTRY.

Accumulators.

Development of the Use of the Storage Battery in the United States. Charles Blizard. Historical outline. 1600 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38723.

Pastes for Accumulator Plates. Translation of article in the *Centralblatt für Accumulatoren und Elementenkunde*, describing experiments made by Dr. Peters. 1500 w. Elect'n, Lond—Jan 4, 1901. No. 38751 A.

The Electric Accumulator. H. C. Schaerer. Read before the Elec, Assn. of N. S. W. Reviews the work in this field, explains the chemical action, and traces the progress made. 3200 w. Aust Min Stand—Nov. 29, 1900. No. 38506 B.

The Storage Battery. Augustus Treadwell, Jr. Historical review, with an account of the uses to which storage batteries have been applied and the success attained. 4000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38678.

Zinc Negatives for Electric Accumulators. Briefly reviews the difficulties met with in employing zinc negatives, and the absolute necessity for purity of all materials used in cells, etc. 1600 w. Auto Jour—Jan., 1901. No. 39009 A.

Electro-Chemistry.

Electro-Chemistry. Carl Hering. Comments on the rapid progress of the last four years, and reviews what is being accomplished, and the future outlook. 5200 w. Elec Wld & Engr—Jan. 5, 1901. No. 38676.

Electrolytic Refining.

The Present Status of the Electrolytic Refining Industry in the United States. Titus Ulke. Part first considers the refining of copper. Silver and gold will be considered in articles following. 1000 w. Elec Rev, N. Y.—Jan. 12, 1900. Serial. 1st part. No. 38727.

Review.

The Electro-Chemical and Electro-Metallurgical Industries in 1900. John B. C. Kershaw. Gives details of the various industries and processes. 5600 w. Elect'n, Lond—Jan. 4, 1901. Serial, 1st part. No. 38758 A.

ELECTRO-PHYSICS.

Energy.

Electrical Energy Direct from Carbon. A. E. Kennelly. A discussion of this subject, indicating where improvement may be looked for in utilizing the energy of coal. 3000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38670.

Frequency.

A Method of Determining the Frequency of Wave Currents (Ueber eine Methode zur Bestimmung der Frequenz Wellenformiger Ströme). R. K. Hartmann. Discussing the use of the resonator and frequency meter, with reproductions of wave photographs. 4500 w. Elektrotech Zeitschr—Jan. 3, 1901. No. 38962 B.

Induction Coil.

A New Induction Coil. W. C. Peckham. Illustrates and describes a large induction coil made for the Japanese government. 1200 w. Sci. Am—Jan. 5, 1901. No. 38534.

Inertia.

Magnetic Inertia (Ueber Magnetische Trägheit). K. Krogh and H. Rikli. A discussion, graphical and analytical, of the behaviour of soft iron ur der magnetisation, as occurring in alternating electrical apparatus. 3500 w. Elektrotech Zeitschr—Dec. 27, 1900. No. 38960 B.

Iron Losses.

The Dependence of Iron Losses Upon Curve Forms (Die Abhängigkeit der Eisenverluste von Kurvenform). Dr. G. Benischke. A discussion of hysteresis and eddy currents as influenced by the wave form of the alternating current. 5000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38967 B.

Radiography.

A Brief History of the X-Ray. Eugene W. Caldwell. 2200 w. Elec Rev, N. Y. Jan. 12, 1901. No. 38724.

Resistance.

The Diminution of Resistance by Cold (Ueber Widerstandverminderung durch Kälte und deren Theoretische Prüfung). R. Mewes. A discussion of the researches of Tesla, Dewar, and Fleming. 5000 w. Elektrochemische Zeitschrift—Jan. 1, 1901. No. 38973 G.

Theories.

Electrical Theories. John Trowbridge. Reviews the theories that have been ad-

vanced, those discarded, and those attracting attention at the present time. 2000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38669.

GENERATING STATIONS.

Amsterdam.

Electrical Works in Amsterdam. A statement of the cost of establishing an electric plant to furnish electricity for street cars, lighting, and motive power. Also a comparative table of cost in different continental cities of Europe. 1500 w. U. S. Cons Repts, No. 935—Jan. 15, 1901. No. 38704 D.

Bipolar Machines.

Report on Bipolar Machines Exhibited at the Paris Exhibition. R. Lloyd-Pearson. Describes the exhibits, and expresses the opinion that in a few years this class of machine will be extinct. 4800 w. Elec Rev, Lond—Jan. 11, 1901. No. 38801 A.

Central Stations.

A Representative American Central Station. An illustrated detailed description of the plant of the Edison Electric Illuminating Company of Brooklyn. 3800 w. Am Elect'n—Jan., 1901. No. 38626.

Evanston, Ill., Central Station for Heating and Lighting. Illustrates and describes the combination of a hot-water system, supplying heat to a territory of six or eight square miles, and an electric-lighting system, both distributed from the same central station. 2000 w. W Elect'n —Dec. 29, 1900. No. 38500.

Mr. Edison's Reminiscences of the First Central Station. 4800 w. Elec Rev, N. Y. —Jan. 12, 1901. No. 38718.

Recent Types of British Central Stations. Illustrates and describes the central station at West Ham, London, and features of some other English plants. 3500 w. Am Elect'n—Jan., 1901. No. 38627.

The Edison Illuminating Company's First Plant. Charles S. Bradley. An account of the plant at 257 Pearl, near Fulton street, New York. 2000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38722.

Commutators.

The Requirements of Good Commutation. John H. Hertner. Explains the theory and practice of commutation. 2300 w. Engr, U. S. A.—Jan. 1, 1901. No. 38562.

Costs.

Electricity Supply Works Costs in 1898 and 1899. Tables and curves giving the actual and average figures of costs, etc., arrived at in analyses of accounts, in the United Kingdom. 4300 w. Elect'n, Lond —Jan. 4, 1901. No. 38749 A.

Dynamos.

Design for a 75-Light Dynamo. Cecil P. Poole. Illustrates the principal features of a dynamo designed to maintain 75 16-c. p. incandescent lamps at 110-120 volts. 1300 w. Am Elect'n—Jan., 1901. No. 38631.

New Commutatorless Dynamo or Motor. James Asher. Aims to show how to construct a dynamo which has neither brushes, commutator nor slip rings, and which will give a perfectly steady current of high tension. 1000 w. W Elect'n—Jan. 5, 1901. No. 38664.

Starting and Stopping Direct-Current Dynamos Operated in Parallel. Alton D. Adams. Considers methods in use. 1600 w. Am Elect'n—Jan., 1901. No. 38633.

The Position of Dynamo Makers in England at the Close of 1900. Reviews the situation and considers the outlook "none too rosy" for the British manufacturers. 1500 w. Elec Rev, Lond—Dec. 28, 1900. No. 38607 A.

Generating Sets.

Direct-Connected Steam Engines and Generators. Frank C. Perkins. Compares American and foreign practice, and also gives illustrated descriptions of apparatus. 3500 w. Ir Age—Jan. 3, 1900. Serial. 1st part. No. 38486.

Generating Set of 800 Kilowatts (Groupe Electrogène de 800 Kilowatts). A. Boudon. Illustrated description of the combined set of compound Corliss engines by Bollinckx, and alternator of the Société Electricité et Hydraulique exhibited at Paris. 2000 w. 1 plate. Génie Civil—Dec. 22, 1900. No. 38903 D.

Generating Set of 1000 Kilowatts (Groupe Electrogène de 1000 Kilowatts). A. Boudon. A description of the Van den Kerchove engine and alternator by the Compagnie Internationale d'Electricité de Liége, exhibited at Paris. 1000 w. 1 plate. Génie Civil—Jan. 12, 1901. No. 38908 D.

Generating Set of 330 Kilowatts (Groupe Electrogène de 330 Kilowatts). G. Henry. An illustrated description of the compound engine by Stork Bros., and continuous-current generator by the Elektrotechnischer Industrie, exhibited at Paris. 1500 w. 1 plate. Génie Civil—Dec. 29, 1900. No. 38905 D.

Generating Set of 1,250 Horse-Power (Groupe Electrogène de 1,250 Chevaux). A. Morizot. Describing the Delaunay-Belleville engine and Breguet alternator, exhibited at Paris. 2500 w. Revue Technique—Dec. 25, 1900. No. 38910 D.

The 3,000 Kilowatt Dynamos of the Berlin Electric Station (Die 3,000 Kw. Dynamos der Berliner Elektricitäts-Werke). Giving details of these fine new examples of alternators built by the Allgemeine-Elektricitäts-Gesellschaft, and of the triple-expansion engines by which they are driven. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 5, 1901. No. 38925 D.

Isolated Plant.

The Electric Light and Power Plant of the Saxon Machnie Works (Die Elektrische Kraft und Lichtanlage der Sächsischen Maschinen Fabrik). W. Philippi. A general description of a large isolated plant in a manufacturing establishment at Chemnitz, Saxony. 6000 w. Elektrotech Zeitschr—Jan. 3, 1901. No. 38961 B.

Load Tests.

Water Loads for Electricity Works. W. E. Warrilow. Illustrates and describes a "home-made" resistance, constructed at small cost, that has proved useful and satisfactory. 1500 w. Elec Rev, Lond—Dec. 28, 1900. No. 38606 A.

Montana.

Notes on Electric Light and Power Work at Butte, Mont. J. R. Cravath. Illustrates and describes the water-power plant of the Montana Power Transmission Co., on the Big Hole River, 20 miles from Butte, the transmission line, and the steam plant at the sub-station in Butte. 1500 w. Elec Wld & Engr—Jan. 26, 1901. No. 38880.

Parallel Running.

Parallel Running for Central Stations. L. R. Lee. Considers three methods of parallel running and the conditions under which each may prove satisfactory. 2200 w. Elec Rev, Lond—Jan. 4, 1901. No. 38702 A.

Polyphase Plant.

New Polyphase Plant of the Commonwealth Electric Company. Illustrated detailed description of a new station on the South Side of Chicago. 5000 w. W Elect'n—Jan. 12, 1901. No. 38824.

LIGHTING.

Arc Lamps.

One Method Dealing with the High Voltage Arc Lamp Trouble. J. G. Griffin. Describes a method that proved successful. 1800 w. Elec Rev, Lond—Jan. 4, 1901. No. 38703 A.

Some Early Arc Lighting Experiences. George W. Stockly. 1000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38719.

Chicago.

Chicago's Lighting Plant: Its Progress Under Municipal Ownership. Edward R. Ellicott. From a paper read before the League of Am. Munic. Favors municipal ownership, and claims the city is saved $160,400 annually. 1400 w. Munic Engng—Jan., 1901. No. 38485 C.

Coast Lighting.

Electric Lights Along the Coast. George E. Walsh. An account of the recent application of electricity to a large number of lighthouses, lightships and signal lights. 1400 w. Elec Wld & Engr—Dec. 29, 1900. No. 38498.

Cold Light.

Light Without Heat. R. A. Fessenden. Discusses methods of lighting, and concludes that in chemical methods the solution of the problem is most likely to be found. 3600 w. Elec Wld & Engr—Jan. 5, 1901. No. 38671.

Crookes Tubes.

Observations on Crookes Tubes. H. Westbury. Read at New York City, before the Roentgen Soc. of the U. S. 2200 w. W Elect'n—Jan. 5, 1901. No. 38665.

Development.

The Electric Light. Richard H. Pierce. Brief review of the development. Ill. 2200 w. W Elect'n—Jan. 5, 1901. No. 38662.

Illumination.

Electric Lighting. Dugald C. Jackson. Calls attention to the great waste in producing the electric light, and the need of correction. 1000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38675.

Incandescence.

The Behavior of Incandescent Electrolytic Bodies (Einiges über das Verhalten Elektrolytischer Glühkörper). W. Nernst and W. Wild. With especial reference to material for the incandescent rod for the Nernst lamp. 1800 w. Zeitschr f Elektrochemie—Dec. 20, 1900. No. 38972 G.

Infirmary.

The Electric Lighting of the Liverpool Royal Infirmary. E. S. Bradburne. Illustrated description of an interesting installation where many precautions were necessary. 1000 w. Elec Engr, Lond—Jan. 18, 1901. No. 39030 A.

Modern Plant.

Modern Electric Lighting Plant. R. D. Summerfield. A short description of electric lighting machinery as used at the present day, including boilers, engines, generators, and all auxiliary plant connected with them. 2200 w. Elec Engr, Lond—Jan. 18, 1901. Serial. 1st part. No. 39031 A.

Nottingham.

Nottingham Corporation Electric Lighting and Tramways. Illustrated detailed description of interesting features of the improved plant. 3300 w. Elec Rev, Lond—Jan 11, 1901. No. 38800 A.

Paris Exposition.

Report on Electric Lighting Exhibits at the Paris Exposition. An advance copy of the official report of Carl Hering in his capacity as U. S. Juror for Class 25. 4500 w. Elec Wld & Engr—Dec. 29, 1900. No. 38496.

Review.

A Review of the History of Electric Lighting. Edwin R. Weeks. 3800 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38720.

Train Lighting.

Electric Lighting for Railway Cars in Germany. A railway accident has caused an investigation into the danger of illumination by gas, and the advantages of electric lighting. 1100 w. U. S. Cons Repts, No. 929—Jan. 8, 1901. No. 38561 D.

The Electric Lighting of Railway Carriages (Die Einführung Elektrischer Beleuchtung des Eisenbahnwagen). A very full discussion before the German Electrotechnical Society, by Dr. Buttner and others. 15000 w. Elektrotech Zeitschr—Jan. 3, 1901. No. 38963 B.

MEASUREMENT.

Charges.

The Wright Current Tariff System (Das Wright'sche Stromtarifsystem). Edmund Hohmann. Giving formulas and a description of a maximum consumption meter upon which charges for electricity supply may be based. 4000 w. Elektrotech Zeitschr—Jan. 17, 1901. No. 38966 B.

Potentiometer.

The Carpentier Potentiometer (Potentiometre J. Carpentier). M. Aliamet. Describing an improved form of the Thomson-Varley bridge for accurate electrical measurements. 1800 w. L'Electricien—Jan. 5, 1901. No. 38970 B.

Temperatures.

Electrical Measurement of Furnace Temperatures. Leonard Waldo. Describes methods used. 1700 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38726.

POWER APPLICATIONS.

Agricultural Experiment.

An Electrically Moved Grazing Pen. A. D. McNair. Describes the application of electricity for the slow moving of a bottomless pen over the grazing field, thus avoiding the tramping of the alfalfa. Ill. 1400 w. Elec Wld & Engr—Jan. 19, 1901. No. 38816.

Crane.

Electric Traveling Crane of 20 Tons Capacity (Pont Roulant Electrique de 20 Tonnes). Illustrated description of 5-motor crane built by Ganz & Co., of Budapest, and exhibited at Paris. There are two trolleys, and three-phase motors are used. 1 plate. 1200 w. Génie Civil—Dec. 15, 1900. No. 38901 D.

Electric Driving.

Electrically Operated Machine Tools. Frank C. Perkins. States the advantages and describes American and foreign practice, illustrating various applications. 2800 w. Mod Mach—Jan., 1901. No. 38553.

Electric Power Machinery in Iron and Steel Works. S. F. Walker. Giving many examples of the practical applications of electric driving in effecting economies in the production of the prime materials of construction. 3500 w. Engineering Magazine—Feb., 1901. No. 38977 B.

The Computation of Resistances, Motors, and Other Details of Electric Driving (Die Berechnung von Widerständen, Motoren und Dergleichen für Aussetzende Betriebe). E. Oelschläger. Giving graphical and analytical methods of computing the various parts of a power system for given conditions. 5000 w. Elektrotech Zeitschr—Dec. 20, 1900. No. 38957 B.

The Electric Distribution of Power in Workshops. Discussion by F. B. Crocker, Gano S. Dunn, W. H. Tapley, and others. Ill. 7800 w. Jour Fr Inst—Jan., 1901. No. 38656 D.

Electric Power.

See Mining and Metallurgy, Mining.

Equipment.

Electrical Equipment of the South-Eastern and Chatham Railway Co.'s Locomotive Sheds at Slade's Green. An illustrated description of a modern plant furnishing electricity for light and power. 2500 w. Elect'n, Lond—Dec. 21, 1900. No. 38468 A.

Gun Equipment.

Electrical Equipment of High Power Guns. Grahame H. Powell. Illustrates and describes the equipment of large-caliber guns. 1100 w. Elec Wld & Engr—Jan. 19, 1901. No. 38815.

Hoists.

Some Recent Tests on Electrically-Driven Hoists. Reports a series of tests made upon two hoists, considering the faults observed to be due, not to the use of electricity, but to the application. Ill. 3000 w. Elec Rev, Lond—Dec. 28, 1900. No. 38608 A.

Polyphase.

Non-Synchronous Polyphase Motor of 600 H. P. and 75 Revolutions (Asynchroner Drehstrommotor von 600 P. S. mit 75 Umdrehungen). A description of a large polyphase motor recently constructed by the Oerlikon works. 1200 w. Schweizerische Bauzeitung—Dec. 29, 1900. No. 38939 B.

Rock Drill.

An Improved Electric Rock Drill (Ueber eine Neue Elektrische Gesteinsbohrmaschine). W. Meissner. An illustrated description of the Lange-Fromholt machine, as made by Siemens & Halske. 2500 w. Glückauf—Dec. 22, 1900. No. 38955 B.

War Services.

The Electrical Engineers R. E. in South Africa. R. E. Crompton. Lecture before the Inst. of Elec. Engs., England. An illustrated account of the war services of the English volunteers. 5600 w. Elect'n, Lond—Dec. 28, 1900. No. 38600 A.

TRANSMISSION.

History.

I. The History of Power Transmission. II. Electric Power Transmission To-Day and To-Morrow. The first article reviews the development. The second, by L. B. Stillwell, considers the present state of this art, and the outlook. 1200 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38725.

Long-Distance.

Power Transmission. Alton D. Adams. On the development of the gas engine in connection with the problems of long-distance power transmission. 3000 w. Min & Sci Pr—Jan. 5, 1901. No. 38688.

Power Transmission.

Electrical Compared with Mechanical Transmission in Factories. H. H. Holding. A comparison, showing that electrical transmission has many advantages. 1400 w. Engr, U. S. A.—Jan. 1, 1901. No. 38563.

Review.

Electrical Power Transmission. Dr. Louis Bell. Reviews the development and remarks its steady progress without failures. 2600 w. Elec Wld & Engr—Jan. 5, 1901. No. 38673.

MISCELLANY.

Outlook.

Electricity in the Coming Century. Elihu Thomson. Reviews the problems awaiting solution, and the probable fields where research will be rewarded. 2000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38668.

Rates.

The Rate Question. Henry L. Doherty. Read at the Milwaukee meeting of the Northwestern Elec. Assn. Describes the system advocated by the writer, and gives his reasons for objecting to the usual methods of charging. 1800 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38878.

Review.

A Century of Electrical Progress. E. E. Fournier d'Albe. An illustrated review. 3700 w. W Elect'n—Jan. 5, 1901. No. 38660.

Electrical Engineering. Editorial review of the present standing in Great Britain, and of the work accomplished. 3800 w. Engr, Lond—Jan. 4, 1901. No. 38741 A.

Electricity in the Nineteenth and Twentieth Centuries. A. E. Kennelly. Reviews the progress made in the century just closed, and discusses where improvements are looked for in the coming century. 4400 w. Am Elect'n—Jan., 1901. No 38628.

One Hundred Years of Electrical Industry and Finance. T. C. Martin. A review of the remarkable progress of an industry now representing an investment of nearly four billions. 2500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38682.

The First Century of Electricity. Charles T. Child. An interesting review of the progress and achievements of the last hundred years. 9500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38713.

GAS ENGINEERING

GAS ENGINEERING.

Accounting.

Book-keeping for Gas-Works. Charles Sandell. The first of a series of articles from a writer of large experience. 3000 w. Gas Wld—Jan. 19, 1901. Serial. 1st part. No. 39029 A.

Calcium Carbide.

Some New Uses for Calcium Carbide. Describes the processes of preparing the carbon, and states uses for the destruction of mildew and phylloxera in vines. 1500 w. Engr, Lond—Jan. 18, 1901. No. 39036 A.

Coal Tar.

The Present Condition of the Coal-Tar Industry. H. W. Jayne. Address at meeting of the Philadelphia Soc. of the Am. Chem. Soc. Reviews the growth of this industry and its present importance. 3000 w. Sci Am Sup—Jan. 5, 1901. No. 38536.

Consumption.

The Effect of Quality of Gas on Consumption. John T. Sheard. A criticism of Mr. Dibdin's paper on this subject. 3500 w. Gas Wld—Jan. 19, 1901. No. 39028 A.

Court Decision.

Text of the Decisions by the Court of Appeals, State of Kentucky, in the Matter of the Status of the Kentucky Heating Company to the Gas Supply of Louisville. 3300 w. Am Gas Lgt Jour—Jan. 7, 1901. No. 38589.

Gas Producer.

Producer-Gas and Its Application. F. J. Rowan. Part first is introductory to the subject. 900 w. Ir & Coal Trds Rev—Jan. 18, 1901. Serial. 1st part. No. 39051 A.

The Morgan Continuous Gas Producer. Gives tabulated results of tests made, and

information regarding the producer. Ill. 1500 w. Ir Age—Jan. 17, 1901. No. 38753.

High-Pressure.

High Pressure Gas for Incandescent Lighting. A. W. Onslow. Gives an account of tests, describing apparatus and methods used, and an estimate of cost. Ill. 2000 w. Gas Engs' Mag—Jan. 10, 1901. No. 39027 A.

Illumination.

Hygienic Artificial Illumination. L. A. W. Alleman. Read before the Med. Soc. of the County of Kings, and published in the *Brooklyn Medical Journal*. The present article considers the sources of light, the chandelier, light saved by the use of reflectors, etc. 3200 w. Pro Age—Jan. 1, 1901. Serial. 1st part. No. 38507.

Impure Air.

Vitiation of Air on Gas Works. R. Gordon Mackay. On the harmlessness of the air in gas-works, and precautions taken to rid the air of dust. 1500 w. Jour Gas Lgt—Jan. 1, 1901. No. 38710 A.

Incandescence.

Prof. V. B. Lewes and the De Lery Light. W. H. Birchmore. A criticism of statements made by Mr. Lewes in relation to the incandescent illumination system known as that of De Lery. 4400 w. Am Gas Lgt Jour—Dec. 31, 1900. No. 38499.

Loss.

In What Manner Can the Normal Loss of Gas in Distribution Be Most Largely Diminished? M. P. H. Gibbons. Read before the Paris Gas Congress. Mentions places where leaks are most likely to occur, and the precautions that should be taken. 3500 w. Gas Engs' Mag—Dec. 10, 1900. No. 38466 A.

Meters.

Meter Testing at the Works and Elsewhere. Part first considers methods of testing and gives an illustrated description of the Parkinson test gasholder. 1600 w. Gas Engineers' Mag—Jan. 10, 1901. Serial. 1st part. No. 39026 A.

Ownership.

Municipal Ownership. Edward Webster Bemis. Testimony presented before the U. S. Industrial Commission. 6000 w. Pro Age—Jan. 15, 1901. No. 38754.

Production.

Coal Gas and Water Gas. Alton D. Adams. Describes how each is produced and compares the several processes of gas production. 2400 w. Munic Engng—Jan., 1901. No. 38482 C.

Regenerator.

The Working of Regenerator Furnaces. S. B. Chandley. Read before the Manchester and District Junior Gas Assn., England. Concerning the construction, general arrangement and working of regenerative settings. 5400 w. Am Gas Lgt Jour—Jan. 14, 1901. No. 38691.

Supply.

Gas Supply. Editorial review of the progress during the century and especially during the last year. 1200 w. Engr, Lond—Jan. 4, 1901. No. 38744 A.

Switzerland.

The Development of the Swiss Gas Works in the Past 20 Years (Die Entwickelung der Schweizerischen Gaswerke in den Letzten Zwanzig Jahren). With diagrams showing the relative progress of Swiss cities. 1000 w. Schweizerische Bauzeitung—Dec. 29, 1900. No. 38940 B.

Water-Gas.

The Manufacture of Water-Gas at the Forty-fourth Street Station, New York. An illustrated description of the plant and its operation. 2000 w. Sci Am—Jan. 19, 1901. No. 38757.

Theory of the Water-Gas Process. H. Strache and R. Jahoda. Abstract translation of articles published in the *Journal für Gasbeleuchtung*. 3000 w. Jour Gas Lgt—Jan. 1, 1901. Serial. 1st part. No. 38711 A.

Zurich.

The New Gas Works at Schlieren, Zurich. A translation, with illustrations, of Herr Weiss's description of these works, which present many interesting constructional details. 2 plates. 5700 w. Jour Gas Lgt—Jan. 1, 1901. Serial. 1st part. No. 38709 A.

MARINE AND NAVAL ENGINEERING

Armour Plates.

See Metallurgy, Iron and Steel.

Battleships.

German Battleship, "Wittelsbach." Criticism of the German type, and particulars of the vessel named. Ill. 1800 w. Engr, Lond—Dec. 28, 1900. No. 38622 A.

Boilers.

The Marine Steam Boiler. William Frederick Durand. An elementary discussion of the principles controlling the generation of steam. 1600 w. Marine Engng—Jan., 1901. No. 38695 C.

Compass.

New Design for Compass Card. A

proposition to do away with compass points, and to use a card graduated in a circle of degrees continuously to the right. Ill. 1000 w. Marine Rev—Jan. 10, 1901. No. 38690.

Destroyers.

The Propelling Machinery of a Torpedo-Boat Destroyer. William David Seton Brown. Reat at meeting of the Newcastle Assn. of Students of the Inst. of Civ. Engs. Discusses the machinery of this class of vessels and the improvements needed. 2500 w. Prac Engr—Dec. 28, 1900. Serial. 1st part. No. 38602 A.

French Navy.

The French Navy. Summary from *Le Yacht*, with comments. 1400 w. Engr, Lond—Jan. 18, 1901. No. 39034 A.

Launch.

A Bullock Electric Launch. Illustrated description of a boat representing the latest practice in electric propulsion for small pleasure craft. 700 w. Marine Engng—Jan., 1901. No. 38694 C.

Life Saving.

Life-Saving Appliances at the Paris Exhibition. Review of the exhibits in competition for the Anthony Pollok prize. Ill. 3800 w. Engr, Lond—Jan. 4, 1901. No. 38735 A.

Light Draught.

The "Sayhueque," a Light Draught Steamer. Illustrated description of the first of three vessels ordered for the Argentine Government, for cargo and passenger service on the Rio Negro. 800 w. Engng—Jan. 4, 1901. No. 38731 A.

Liner.

Magnificent New Liner. Illustration and detailed description of the "Vaderland" of the New York and Antwerp Line. 2700 w. Naut Gas—Dec. 27, 1900. No. 38503.

New Transatlantic Liner "Vaderland" for the Red Star Line. Illustration, with description of the vessel and its equipment. 2000 w. Marine Engng—Jan., 1901. No. 38692 C.

Liquid Fuel.

Liquid Fuel Burning Steamer "Bulysses." Illustration and description of a tank steamer of nearly 8,500 tons, and the appliances for burning the liquid fuel. 1000 w. Engng—Dec. 28, 1900. No. 38612 A.

Marine Engines.

Engines and Boilers of the "Inchdune" and "Inchmarlo." Illustrated description of marine machinery, of interest because of the construction and the highly economical results obtained. 2200 w. Engng—Jan. 18, 1901. No. 39041 A.

The Marine Engineer. Howard Patterson. Discusses his present opportunities and prospects. 1300 w. Naut Gaz—Dec. 27. 1900. No. 38505.

Merchant Marine.

Merchant Marine of France. Résumé of a report made by Mr. Thierry, Deputy from Marseilles, in the name of the budget committee of 1900 of the Chamber of Deputies. 3300 w. U. S. Cons Repts, No. 927—Jan. 5, 1900. No. 38520 D.

The Progress of the Continental Merchant Marine. Information concerning various continental shipyards, and the work in progress. 3000 w. Engr, Lond—Dec. 28, 1900. No. 38620 A.

Naval Power.

The Engineering Crisis in the Navy. D. B. Morison. Read before the Inst. of Engs. and Shipbuilders in Scotland. A supplementary paper to one read last March on "The British Naval Engineer." Calls attention to recent developments, and the broader aspects of the question. 3500 w. Engng—Jan. 4, 1901. Serial. 1st part. No. 38733 A.

Repairs.

Emergency Repairs of Electrical Machinery on Board Ship. William Baxter, Jr. Considers expedients that may be resorted to temporarily, until port is reached. 2100 w. Marine Engng—Jan., 1901. Serial. 1st part. No. 38696 C.

Shipbuilding.

New Vessels Under Construction. A record of the craft under construction in United States shipyards. 7000 w. Naut Gaz—Jan. 10, 1901. No. 38687.

Shipbuilding and Marine Engineering in 1900. A review of the statistics of this industry in the United Kingdom. 3500 w. Engng—Jan. 4, 1901. Serial. 1st part. No. 38730 A.

Shipbuilding in the United States During the Past Year. A review of this industry, with a list of all steam vessels, sailing vessels, and sea-going barges of over 500 tons which have been launched in the United States during the past year. Ill. 9500 w. Naut Gaz—Jan. 3, 1901. No. 38597.

The Development of British and German Shipbuilding (Einiges aus der Entwickelung des Deutschen und des Englischen Schiffbaus). With comparative outlines of many vessels, and diagrams of dimensions and performances. 3000 w. Glaser's Annalen—Dec. 15, 1900. No. 38928 D.

Ship Heating.

The Ventilation and Heating of Ships by a Forced Circulation of Warm Air. F. W. Jennings. Abstract of a paper read before the N. E. Coast Inst. of Engs. and Shipbuilders. An illustrated description of the plenum system. 2500 w. Engs' Gaz—Jan., 1901. No. 38705 A

Shipping Bill.

Revival of American Shipping. Marcus A. Hanna, in the *National Magazine*. How the bill now before the U. S. Congress proposes to bring about a return of the over-sea trade in American vessels. 3000 w. Marine Rev—Jan. 24, 1901. No. 39024.

Ship Telegraph.

See Electrical Engineering, Communication.

Shipyard.

Great Virginia Shipyard. Illustrated description of the plant of the William R. Trigg Company, at Richmond, Va. 1500 w. Naut Gaz—Jan. 17, 1901. No. 38775.

Steamships.

Mammoth Steamships. Illustration, with description of the new Hill passenger and freight boats, the largest craft ever built. They are intended for trans-Pacific trade, and will be 21,000 tons gross register, costing $2,500,000 each. The product of an American shipyard. 1400 w. Naut Gaz—Jan. 10, 1901. No. 38686.

Steamship Performance. Comments on the performance of steamships hired as transports, and the inability of a vessel designed for a special voyage to maintain the same qualities for a totally different passage. 1200 w. Engr, Lond—Jan. 11, 1901. No. 38807 A.

Submarine.

The Admiralty and Submarine Boats. Edmund Robertson. On the attitude of the British Admiralty, and also comment on what has been done in France and the United States. 4400 w. Nineteenth Cent—Jan., 1901. No. 38793 D.

The Development and Future Possibilities of the Submarine Boat. Editorial criticism of statements made by John P. Holland, the inventor of the Holland submarine boat. 2500 w. Eng News—Jan. 10, 1901. No. 38649.

The French Submarine Boats. The latest information concerning these boats, with editorial discussion. 4000 w. Engr, Lond—Jan. 18, 1901. No. 39033 A.

Subsidies.

Substitutes for Ship Subsidies. Louis Windmüller. A discussion of the subsidy bill before the U. S. Congress, claiming it will not accomplish its avowed objects, and offering suggestions. 3000 w. N Am Rev—Jan., 1901. No. 38519 D.

Turbine.

Turbine Propulsion for a New Clyde Passenger Steamer. An account of a vessel to do service between Fairlie and Campbeltown. 1200 w. Engr, Lond—Jan. 11, 1901. No. 38811 A.

Twin-Screw Boat.

Twin-Screw Combined Fire, Tug, and Police Boat. Illustrates and describes a seaworthy vessel built for the Mexican Government. 900 w. Engng—Jan. 11, 1901. No. 38834 A.

Warships.

Progress of Warships and Machinery Building in England. Supplementary to an article published June 29. The present article gives a résumé of progress during the latter half of the expiring year. 3500 w. Engr, Lond—Dec. 28, 1900. No. 38618 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Automobile Station.

The New Station of the New York Electric Vehicle Transportation Company. R. A. Fliess. Reviews the history of this company, and begins an illustrated description of the building. 5700 w. Elec Wld & Engr—Jan. 5, 1901. Serial. 1st part. No. 38666.

Berlin Trials.

The Berlin Electromobile Trials. Gives the chief results of the 14 vehicles tested by Dr. M. Kallmann, with their leading characteristics. 1000 w. Auto Jour—Jan., 1901. No. 39008 A.

Business Vehicles.

Early Developments. William H. Maxwell, Jr. Showing the practicability of the commercial vehicle, and that it is cheaper than the horse. Illustrates three trucks. 3000 w. Auto Mag—Jan., 1901. No. 38478 C.

The Motor Wagon for Business and a New Power Transmission Device. A. H. Chadbourne. Discusses the requirements of the successful motor wagon, and describes some new devices. Ill. 2500 w. Auto Mag—Jan., 1901. No. 38479 C.

Delivery Wagons.

The Electric Delivery Equipment of a Large New York Store. Max Loewenthal. An illustrated account of the automobile delivery service of B. Altman & Co. 3200 w. Elec Wld & Engr—Dec. 29, 1900. No. 38495.

Design.

Electric Vehicle Design. H. M. Underwood. Discusses the defects in construction, and illustrates and describes the omnibus of the Hewett-Lindstrom Motor

Co. 1800 w. Auto Mag—Jan., 1901. No. 38480 C.

Motor Vehicles.

Electric Automobiles. Henry F. Joel. Gives a brief criticism of the early attempts to produce successful electric carriages, outlining the defects that caused failures, and predicting future success. 4900 w. Elec Rev, Lond—Jan. 4, 1901. No. 38699 A.

Electromobile Evolution. W. H. Maxwell, Jr. What has been accomplished in this field, and the outlook. 3500 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38716.

The Automobile. Harold H. Eames. Considers the future of this industry more likely to be determined by commercial considerations than by any mechanical advance. 4500 w. Elec Wld & Engr—Jan. 5, 1901. No. 38679.

Steam Vehicle.

The Musker Steam Wagon. Illustrates and describes an English vehicle, aiming at automatic control, and having the machinery carried on a separate under frame. 3000 w. Auto Jour—Jan., 1901. No. 39007 A.

Tyres.

Elastic Tires for Wheels (Bandages Elastiques pour Roues). Leo Dex. A general discussion of pneumatic and cushion tires, with reference to an improved form of cellular tire. 2000 w. Revue Technique—Dec. 25, 1900. No. 38912 D.

Report on Elastic Tires. M. Michelin. Presented at the International Automobile Congress. Reviews the history of tires, properties of elastic tires, experiments made, etc. 4800 w. Horseless Age—Jan. 2, 1901. No. 38524.

Washington, D. C.

The Washington, D. C., Electric Automobile Service. Illustrated description of the fine plant. 1700 w. Elec Wld & Engr—Jan. 26, 1901. No. 38881.

HYDRAULICS.

Hydraulic Power.

Hydraulic Power Plant, Montmorency Falls, Canada. George W. Bowie. An illustrated detailed description of the power and generating station of the Quebec Railway, Light and Power Co. 2800 w. Engr, Lond—Jan. 11, 1901. No. 38810 A.

Practical Notes on Water Power for Electrical Purposes. F. R. Yorke. Read before the Glasgow Sec. of the Inst. of Elec. Engs. Discusses some of the principal types of plant used in Gt. Britain, indicating the conditions for which they are suited, and dealing with practical details. 4000 w. Elect'n, Lond—Jan. 11, 1901. No. 38846 A.

Pumps.

Hydraulically-Driven Pumps (Hydraulisch Betriebene Wasserhaltungsmaschinen). Fr. Frölich. Describing the use of hydraulic motors for operating mine pumps, with especial reference to the Kaselowsky system. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38916 D.

Modern Pumping Machinery (Neuer Pumpmaschinen). G. ter Meer. Especially discussing improved forms of Riedler express-pumps driven direct by electric motors. Two articles, 10000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 5, 12, 1901. No. 38924 each D.

The Riedler Express Pumps (Les Pompes Express Riedler). M. Rony. With especial reference to high-speed electrically driven pumps with the Riedler mechanically moved valves. 2500 w. Revue de Mécanique—Dec. 31, 1900. No. 38945 H.

Siphon.

A Successful Siphon. Robert S. Hale. Describes the solution of a problem for supplying water to Schooner Head, Bar Harbor, Me. Used an air-tight siphon at a cost of about $250. Ill. 1500 w. Jour Assn of Engng Socs—Nov., 1900. No. 38636 C.

MACHINE WORKS AND FOUNDRIES.

Air Hammer.

Experiments on an Air Hammer (Versuche mit einem Lufthammer). Prof. A. Lüdicke. A report upon researches made with the indicator and dynamometer upon an Arns pneumatic hammer, used for rivetting railway tires upon the wheels. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 29, 1900. No. 38921 D.

Boiler-Making.

Belleville Boiler-Making Machinery. Illustrated description of special machine tools. 800 w. Engr, Lond—Dec. 28, 1900. No. 38621 A.

Boring.

Mechanism for Boring Elliptical Cylinders. C. W. MacCord. Showing how an elliptical cylinder of any length can be finished inside by the use of an ordinary boring bar, turning in fixed bearings with uniform velocity. 1200 w. Stevens Ind—Jan., 1901. No. 38888 D.

Brakes.

Band Brakes. C. F. Blake. A diagram with directions for obtaining their proportions. 1200 w. Mach, N. Y.—Jan., 1901. No. 38533.

Brass Foundry.

Fitting Up a Brass Foundry. C. Vickers. Considers the internal arrangements

of a brass foundry. 1600 w. Am Mach—Jan. 17, 1901. No. 38776.

Bridge Shop.

Construction and Equipment of a Bridge Shop Plant. Illustrated description of works, having numerous novel methods of handling tools and work; using electric power transmission. 1600 w. Eng Rec—Jan. 5, 1901. No. 38568.

Cast Iron.

Characteristics of the Chemical and Physical Properties of Cast Iron. Thomas D. West. A lecture delivered before Sibley College. Shows the utility of chemical analyses, and discusses the effects of treatment and composition. Ill. 4000 w. Sib Jour of Engng—Jan., 1901. Serial. 1st part. No. 38837 C.

Crane.

See Electrical Engineering. Power Applications.

Dies.

A Novel and Ingenious Cutting and Bending Die. George W. Freeman. Illustrated description of the making of the die and its operation. 500 w. Am Mach—Jan. 24, 1901. No. 38865.

Dies for Drawing Wire: Their Manufacture and Use. William D. Pierson. Information concerning materials used for dies, and the methods of wire drawing. 900 w. Stevens Ind—Jan., 1901. No. 38887 D.

Electric Driving.

See Electrical Engineering. Power Applications.

Foundry Appliances.

Pneumatic Tools and Appliances in Foundry Service. W. P. Pressinger. Reviews briefly the various appliances which have lightened labor and reduced costs, that are dependent upon compressed air for their power. Ill. 2500 w. Jour Am Found Assn—Jan., 1901. No. 38521 C.

Hoists.

See Electrical Engineering. Power Applications.

Interchangeable Parts.

Manufacture by the System of Interchangeable Parts. E. G. Parkhurst. Describes old methods of work, and the systems in use in the United States and Germany, and gives information of interest. Ill. 4300 w. Am Mach—Jan. 3, 1901. No. 38544.

Krupp.

The Krupp Works in 1900 (Les Etablissements Krupp en 1900). G. Bresson. A review of the development of the Krupp works up to the time of the Exposition of 1900, with statistics of production, etc. 1200 w. Génie Civil—Dec. 22, 1900. No. 38904 D.

Laboratory.

A Practical Laboratory. Illustrated description of the laboratory of the J. I. Case Threshing Machine Co., Racine, Wis. 2300 w. Ir Age—Jan. 24, 1901. No. 38843.

Labour Remuneration.

The Application of Piece-Work and the Premium Plan. Sir B. C. Browne. A discussion of the importance and relative fields of the premium and piece-work systems from a British view-point. 3000 w. Engineering Magazine—Feb., 1901. No. 38981 B.

Machine Tools.

The Early Machine Tools of Henry Maudslay. W. A. S. Benson. An illustrated historical sketch of the products of an old English firm. 3000 w. Engng—Jan. 18, 1901. Serial. 1st part. No. 39039 A.

Molding.

Machine Molding. I. L. McCord. Read at a meeting of the Foundrymen's Assn. Considers the application of molding machines to foundry work, the saving in cost, the various machines, etc. 4500 w. Foundry—Jan., 1901. No. 38525.

Organization.

The Organization of the Factory Sales Department. O. D. Hogue. A discussion of the most effective means toward trade extension and prosperity in manufacturing industries. 2500 w. Engineering Magazine—Feb., 1901. No. 38976 B.

Paper-Making.

Paper-Making Machinery at the Paris Exhibition. Illustrated description of a few of the exhibits, seen in actual working. 1700 w. Engng—Jan. 18, 1900. Serial. 1st part. No. 39043 A.

Punching.

Drawing and Punching Continuous Strips of Half Balls. Joseph V. Woodworth. Illustrates the punch and die used, and describes the work. 900 w. Am Mach—Jan. 24, 1901. No. 38863.

Punch Press.

A Special Punch Press. Joseph V. Woodworth. Illustrated detailed description. 1600 w. Am Mach—Jan. 3, 1901. No. 38546.

Shop Lighting.

Experiments on the Diffusion of Light Through Prismatic and Ribbed Glass Windows. Abstract of the conclusions of a report made by Charles L. Norton, on a series of tests conducted for the Associated Factory Mutual Companies of New England. 1500 w. Eng News—Jan. 10, 1901. No. 38651.

Shops.

The New Shops of the Woodward &

Powell Planer Co., Worcester, Mass. Illustrated description of the shops, system used, methods of manufacture, etc. 2800 w. Mach, N. Y.—Jan., 1901. No. 38532.

Squares.

The Making of a Real Square. Theodore H. Miller. Illustrates and describes a square made for very accurate work, and the manner of testing. 3000 w. Am Mach—Jan. 3, 1901. No. 38545.

Steel Works.

The Granite City Plant of the National Enameling and Stamping Company. Illustrated detailed description of a plant designed for a special product of open-hearth steel suitable for enameling, and for making granite ware. 3000 w. Ir Age—Jan. 10, 1901. No. 38596.

Welding.

The Metallurgical Uses of Aluminum. From the *Revue Industrielle*. Illustrates and describes some of the applications of the properties of aluminum as utilized in the Goldschmidt process. 4000 w. Sci Am Sup—Jan. 5, 1901. No. 38535.

The Process of Aluminothermy (L'Industria Allumino-Termica). Giorgio Levy. An illustrated account of the working of the Goldschmidt process for welding metals by the heat produced by the combustion of aluminum. 2500 w. L'Elettricita—Dec. 15, 1900. No. 38971 B.

The Welding of Defective or Worn Pieces (Ausschweissen Schadhafter oder Abgenutzter Werkstücke). Dr. H. Goldschmidt. A description of the Goldschmidt process of aluminotherme for welding new journals or rolls, or making other repairs. 1000 w. Stahl und Eisen—Jan. 1, 1901. No. 38938 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Mechanical and Other Treatment of Alloys of Aluminum and Magnesium. Information relating to the manipulation of magnesium alloys of aluminum. 800 w. Am Mach—Jan. 24, 1901. No. 38862.

Bronze.

Experiments Upon the Effect of Temperature on the Resistance and Ductility of Bronze (Versuche über die Abhängigkeit der Festigkeit und Dehnung der Bronze von der Temperatur). C. Bach. A very full record of experiments, with tables and diagrams. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 22, 1900. No. 38919 D.

Copper Castings.

Making Sand Castings of Copper. C. Vickers. Gives methods of making copper castings solid, and the effect of various alloys. 1200 w. Am Mach—Jan. 24, 1901. No. 38864.

Impact Tests.

Tension Impact Tests of Rolled Steel. S. Bent Russell. Gives results of experiments made. Ill. 2000 w. Eng News—Jan. 3, 1901. No. 38551.

Low-Steel.

The Influence of Bending and Straightening Upon the Resistance of Low Steel (Einfluss des Biegens und Richtens auf die Festigkeitseigenschaften von Flusseisen). Prof. M. Rudeloff. Giving tabulated and plotted results of experiments at the Charlottenburg testing laboratory. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 12, 1901. No. 38927 D.

MEASUREMENT.

Board Measure.

Logarithmic Table of Board Measure. W. H. Sargent. Gives chart with explanation of the method of using it. 400 w. Am Mach—Jan. 24, 1901. No. 38861.

POWER AND TRANSMISSION.

Compressed Air.

A New Riedler Air Compressor. Illustrated description of a vertical engine with compound air and steam cylinders, and an unusual connection between the piston rods and fly-wheel shafts: the machine is rated at 6,860 cu. ft. of free air per minute at 80 lbs. pressure. 400 w. Eng Rec—Jan. 26, 1901. No. 39016.

Compressed Air—the Ideal Motive Power. Henry D. Cooke. Reviews the history of its application to tramways, and for other uses, and discusses the outlook. 2000 w. St Ry Rev—Jan. 15, 1901. No. 38856 C.

Multiple Stage Air Compression. John H. Barr. Read before the Cornell Soc. of Mech. Engs. Illustrates and describes single stage, two stage and three stage compression, and gives a comparison of the probable performances. 3000 w. Sib Jour of Engng—Jan., 1901. No. 38838 C.

Power.

A Combination Hydraulic and Steam Power Plant, Stuyvesant Falls, N. Y. Illustrated description of a 3,500 H. P. station for operating a third rail electric line 97 miles long, and furnishing current for power and lighting. 2100 w. Eng Rec—Jan. 5, 1901. No. 38566.

Ropeway.

Ropeway at the New Beachy Head Lighthouse. Describes the arrangement of a ropeway used in the construction of a new lighthouse, which was used not only for the transportation of materials, but of machinery and workmen. Ill. 1600 w. Engng—Jan. 11, 1901. No. 38832 A.

SPECIAL MOTORS.

Gas Engines.

New Types of Gas Engines (Les Types Nouveaux de Moteurs à Gaz). J. Deschamps. With especial reference to en-

gines of large power, used with furnace or producer gas. 2500 w. Génie Civil—Jan. 12, 1901. No. 38909 D.

The Gas Engine at the Beginning of the Twentieth Century. J. D. Lyon. A consideration of the present and future of the gas engine. 2000 w. Am Mfr—Jan. 3, 1901. No. 38581.

The Koerting Two-Cycle 350 Brake Horse-Power Gas Engine. Illustrated description of a two-cycle double-acting engine resembling a steam engine. The test gave interesting results. 1400 w. Engr, Lond—Jan. 4, 1901. No. 38745 A.

Gasoline Engine.

The Howard Gasoline Launch Engine. Herbert L. Towle. Illustrated description of the Howard marine motor, exhibited at Madison Sq. Garden, N. Y., from Nov. 3 to 10, 1900. 1300 w. Am Mach—Jan. 24, 1901. No. 38866.

STEAM ENGINEERING.

Water Motor.

Test of a New Impulse Water Motor. R. C. Carpenter. Record of tests of a twelve-inch motor, belonging to the same general class as the Pelton. 500 w. Sib Jour of Engng—Jan., 1901. No. 38839 C.

Boiler Auxiliaries.

Auxiliary Steam and Water Appliances for Water-Tube Boilers. B. H. Thwaite. Especially discussing automatic feed supply and regulation devices, separators and similar apparatus for aiding in the steady and satisfactory operation of water-tube boilers. 2500 w. Engineering Magazine—Feb., 1901. No. 38978 B.

Boiler Temperature.

Investigations Into the Temperature Relations in the Interior of a Portable Boiler (Untersuchung über die Temperaturverhaltnisse im Innern eines Lokomobilkessels). C. Bach. The readings of thermometers inserted at various points are tabulated and plotted as curves, with discussion. 1200 w. Zeitschr d Ver Deutscher Ing—Jan. 5, 1901. No. 38926 D.

Boilers.

See Marine and Naval Engineering.

Chimneys.

See Architectural Engineering, Construction.

Compound Engine.

Compound Engine of 150 Horse-Power for Electric Driving (Verbunddampfmaschine von 150 Ps. für Dynamobetrieb). L. Kliment. Giving sectional drawings showing special valves, valve gear and governor. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 29, 1900. No. 38923 D.

Connecting Rods.

On the Stress Produced in a Connecting Rod by Its Motion. C. H. Innes. Showing a method of arriving mathematically at the stress, and the point of greatest stress, and to give simple algebraic formulæ for calculating it for various forms of rod. 900 w. Prac Engr—Jan. 11, 1901. Serial. 1st part. No. 38831 A.

Economy.

Economy in Steam Engine Practice. John Goodman. Read at Inst. of Min. Engs., England. Considers what should be avoided, and the essential details. 2800 w. Naut Gaz—Dec. 27, 1900. No. 38504.

Fuel.

Gas Still the Cheaper Fuel. A. J. Hollis. Reports recent trials at one of the largest steel plants in the Pittsburg district to determine the relative costs of natural gas, and the best Pittsburg coal. 1000 w. Am Mfr—Jan. 3, 1901. No. 38583.

Governing.

The Design of Steam Engines with Respect of Regulation (Detérmination de Certains Elements des Moteurs à Vapeur en Vue de la Régulation). M. Delaporte. Showing the influence of the dimensions of ports, steam chests, receivers, etc., upon the regulation, and deriving formulas for their proportion. 3000 w. Revue de Mécanique—Dec. 31, 1900. No. 38943 H.

The Rites Shaft Governor. Charles Buerger. Mathematical study of the equilibrium positions, and the so-called "inertia effect." 1800 w. Ill. Stevens Ind—Jan., 1901. No. 38889 D.

Heat Transmission.

The Transmission of Heat Through Heating Surfaces (Ueber den Wärmedurchgang durch Heizflächen). L. Holborn and W. Dittenberger. An account of researches conducted at the Reichsanstalt, with especial reference to boiler heating surface. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38917 D.

Marine Engines.

See Marine and Naval Engineering.

Progress.

A Century of Progress in Steam Engineering. A. F. Nagle. Considers the position one hundred years ago, the progress during the century, and what remains to be accomplished. 3000 w. Am Elect'n—Jan., 1901. No. 38629.

Revealer.

Theory of the Steam Engine and the Donkin Revealer (La Théorie de la Machine à Vapeur et le Révélateur Donkin). Joseph Nadal. A discussion of cylinder condensation as modified by the results obtained with the Donkin revealer. 4500 w. Revue de Mécanique—Dec. 31, 1900. No. 38944 H.

Stationary Engines.

The Evolution of the Stationary Steam Engine. Andrew Robert Robertson. From Trans. Inst. C. E. Reviews the history of the development. 5200 w. Prac Engr—Dec. 21, 1900. No. 38469 A.

Steam Engines.

Improvements in the Steam Engine. W. H. Wakeman. Practical problems in design and construction, installation and operation met in every day experience. Ill. 2500 w. Mod Mach—Jan., 1901. Serial. 1st part. No. 38555.

The Steam Engine of To-day in the Field of Electrical Engineering Practice. R. H. Thurston. A study of the progress of the later years of the nineteenth century. 6000 w. Elec Wld & Engr—Jan. 5, 1901. No. 38672.

Steam Heating.

See Architectural Engineering, Heating.

Steam Turbine.

Test of a Parsons Steam Turbine Driving a 1,000-Kilowatt Alternator. Illustrated abstract of a report of tests of such a unit for the city of Elberfeld, Germany, showing its economy and regulation at different loads. 1000 w. Eng Rec—Jan. 26, 1901. No. 39014.

Superheating.

How High Shall Steam Be Superheated (Wie Hoch Soll Dampf Ueberhitzt Werden). Josef Jedlicka. An exhaustive examination of the subject, to determine the most economical degree of superheating for given conditions. Three articles, 1 plate. 8000 w. Oesterr Zeitschrift Berg u Hüttenwesen—Dec. 29, 1900. No. 38952 each B.

Thermodynamics.

Elementary Graphics and Geometry of Thermodynamics. Robert H. Thurston. A graphical study of the principles of thermodynamics. 4500 w. Jour Fr Inst—Jan., 1901. Serial. 1st part. No. 38659 D.

MISCELLANY.

Arbitration.

Arbitration: Its Place in Our Professional Practice. G. Alexander Wright. Read before the Tech. Soc. of the Pacific Coast, arguing in favor of arbitration as the quickest and most inexpensive process of settling vexatious disputes. 6000 w. Jour Assn of Engng Socs—Nov., 1900. No. 38635 C.

Arbitration of Labor Questions Necessary to Industrial Supremacy. Charles B. Going. Showing that the wastefulness of labor wars is fatal to industrial supremacy, and holding arbitration to be the only remedy. 3000 w. Engineering Magazine—Feb., 1901. No. 38982 B.

Industrial Arbitration. Chauncey H. Castle. An address before the National Arbitration and Conciliation Convention. Reports the experience of the Stove Founders' National Defense Assn. 4000 w. Ir Age—Jan. 3, 1900. No. 38487.

Armstrong.

Lord Armstrong. Biographical sketch, with portrait, giving interesting information of his work. The Armstrong gun is described. 5300 w. Engr, Lond—Jan. 4, 1901. No. 38738 A.

Card Index.

The Card Index and Its Service in Machine Works (Das Kartenverzeichnis und der Anzeiger im Dienste der Maschinen fabriken). A. S. Oesterreicher. With various illustrations of the application of the card-index system to matters of record and accounting. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38918 D.

Industrial Ascendency.

Industrial Ascendency of the Anglo-American Peoples. C. L. Redfield. A discussion of the racial, educational, and territorial advantages which assure Anglo-American industrial supremacy. 3000 w. Engineering Magazine—Feb., 1901. No. 38975 B.

Invention.

Invention and Usage (Gebrauchsmuster und Erfindung). Dr. Scharze. A review of German patent law, showing the extent to which previous usage and the state of the art influences legislation in regard to patented inventions. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 22, 1900. No. 38920 D.

Machinery.

Arithmetic of Machinery. A series of practical and instructive talks to serve as evening studies for machinists, mechanics, and apprentices. Ill. 600 w. Mod Mach—Jan., 1901. Serial. 1st part. No. 38554.

Refrigeration.

Erecting Cold Stores in South Africa. Albert Moon. Interesting description of conditions in South Africa and the erection of a cold storage plant while war was in progress. 1600 w. Ice & Refrig—Jan., 1901. No. 38575 C.

Ice Making in France. Views and descriptions of an ice-making and cold storage plant at Rouen, France. American machinery and methods preferred. 700 w. Ice & Refrig—Jan., 1901. No. 38573 C.

Jacob Ruppert's Ice Plant in New York. Illustrated detailed description of the largest ice-making plant in the world, the construction of the buildings, machinery installed, etc. 5600 w. Ice & Refrig—Jan., 1901. No. 38572 C.

Mexican Brewery and Ice Plant. Illus-

trated description of an ice and refrigerating plant at the Cerveceria Moctezuma, Mexico. 1400 w. Ice & Refrig—Jan., 1901. No. 38574 C.

The Production of Distilled Water for Ice-Making Plants. Hal Williams. Read at meeting of the Cold Storage and Ice Assn., England. Illustrated description of apparatus used, and of the process. 3800 w. Engr, Lond—Dec. 28, 1900. No. 38623 A.

Review.

Mechanical Engineering. Editorial, calling attention to the practice of one hundred years ago and its lessons and the present standing and future outlook. 3700 w. Engr, Lond—Jan. 4, 1901. No. 38740 A.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Warrior Coal Basin of Alabama. Henry McCalley. Its location, geological peculiarities, the thickness of the coal seams, and facilities for transportation. 2300 w. Mines & Min—Jan., 1900. No. 38475 C.

Briquettes.

Briquetting—Its Progress and Commercial Advantages. Henry S. Mould. An illustrated description of various types of the White Briquetting Press. 2200 w. Am Mfr—Jan. 17, 1901. No. 38818.

Britain.

The Coal Question in 1900. A review of its different aspects and a summary of the history of the past year in England. 3000 w. Jour Gas Lgt—Jan. 1, 1901. No. 38708 A.

Coal-Fields.

The Makum Coal-Field in Assam. George E. Harris. Abstract of a paper read before the Manchester Geol. Soc. Describes these fields in India, the deposits and collieries of this district, and the transportation facilities. 1200 w. Eng & Min Jour—Jan. 26, 1901. No. 39020.

Coal Trade.

The Lancashire Coal Trade in 1900. T. B. Wood. Reviews the output, prices and conditions affecting this industry. 2200 w. Ir & Coal Trds Rev.—Dec. 28, 1900. No. 38613 A.

Crusher.

Coal Crushers (Ueber Kohlenstampvorrichtungen). Describing improved coal crushers for use in conection with coping, briquetting, and the preparation of gas coals. 2000 w. Stahl und Eisen—Dec. 15, 1900. No. 38936 D.

Cutting Machinery.

Coal-Cutting by Machinery. The first of a series of articles treating of the progress made as regards the introduction of this machinery in the United Kingdom, the difficulties and the conditions which conduce to success or failure. 2200 w. Col Guard—Jan. 4, 1901. Serial. 1st part. No. 38747 A.

Opening-Out Coal Royalties by Machinery. Illustrates and describes the Stanley coal-heading machine used at the Nuneaton new colliery. 1100 w. Col Guard—Jan. 11, 1901. No. 38826 A.

Firedamp.

Precautions Against Firedamp at the Saint Etienne Collieries. Illustrates and describes the automatic sample-taker of mine air, invented by Paul Petit. 1500 w. Col Guard—Jan. 18, 1901. No. 30062 A.

Foreign Trade.

The Foreign Coal and Iron Trades in 1900. Briefly reviews the various European countries, in the production of these products, the prices and general conditions. 5500 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38615 A.

French Colliery.

Bessèges Collieries at the Paris Exhibition. Describes the interesting exhibit of this colliery, the working, etc. 4600 w. Col Guard—Dec. 28, 1900. No. 38611 A.

Hungary.

Coal-Mining in Hungary. Gives the history, geology and statistics. 1100 w. Col Guard—Jan. 11, 1901. No. 38827 A.

Natal.

Coal and Iron in Natal. Information relating to these industries, the methods used, deposits, etc. 2000 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38616 A.

Nineteenth Century.

The Nineteenth Century—Its Makers and Its Achievements. Part first deals with the progress made in coal-mining during the century. Also the handling and transportation, markets, etc., from the English point of view. 4300 w. Ir & Coal Trds Rev—Jan. 4, 1901. Serial. 1st part. No. 38697 A.

Peat.

Peat Fuel in Ontario. Describes the apparatus of the Trent Valley Peat Fuel Co. for converting the moist, spongy peat into dry, compact briquettes. 1300 w. Col Guard—Jan. 11, 1901. No. 38830 A.

Production.

Coal in 1900. An output greater than in 1899, and the increase principally from the United States. Reports from various districts. 10300 w. Eng & Min Jour—Jan. 5, 1901. No. 38594.

Raising.

A Proposed New Method to Raise Coal, etc., in Shafts. W. S. Gresley. From the Trans. of the S. Wales Inst. of Engs. Describes a scheme for slow-speed hoisting, doing away with winding, and hoisting the coal in trams, or other receptacles, without the employment of drum or rope. 1800 w. Col Guard—Dec. 28, 1900. No. 38609 A.

Saint Etienne.

The Saint-Etienne Collieries (Loire), France. Describes the exhibits made at the Paris Exhibition and gives statistics. Ill. 3000 w. Col Guard—Jan. 4, 1901. No. 38748 A.

Scotland.

The Carboniferous Limestone Coals of Scotland. R. W. Dron. Read before the Geol. Soc. of Glasgow. Descriptive. 2500 w. Col Guard—Jan. 18, 1901. No. 39053 A.

Trade.

The Coal Trade of 1900. A review of the various mining districts of Great Britain. 11800 w. Col Guard. Jan. 4, 1901. No. 38746 A.

Vancouver.

Coal Mining on Vancouver Island. R. Lind Watson. Facts in regard to the mines which have been opened and the amount and method of development. Ill. 3000 w. Miners & Min—Jan., 1901. No. 38472 C.

COPPER.

Copper.

See Mechanical Engineering Materials.

Copper Industry.

The Lake Superior Copper Industry. Horace J. Stevens. Reviews the prosperous year of 1900. 3000 w. Ir Age—Jan. 3, 1901. No. 38492.

Extraction.

New Methods for the Extraction of Copper and Zinc. Dr. J. Ohly. Describes the process recently invented by C. G. Collins, employing the "nitre cake" and the process invented by Nicolas Leblanc employing the "salt-cake." 2700 w. Min & Sci Pr—Dec. 29, 1900. No. 38529.

Leaching.

The Leaching of Copper Ores. J. Ohly. Suggestions and facts of value in working these deposits. 2100 w. Min & Sci Pr—Jan. 19, 1901. Serial. 1st part. No. 38868.

Mining.

Copper Mining in the United States. Waldon Fawcett. Historical review of the development of this industry, the progress and improvement of methods and facilities, briefly describing the equipment of the Calumet and Hecla mine, as an example of present practice. Ill. 1700 w. Am Mfr—Jan. 24, 1901. No. 39025.

Production.

Copper in 1900. Estimates based upon the statistics collected by Mr. John Stanton, who receives the reports of all the large producing companies. Also a review of the copper market. 3500 w. Eng & Min Jour—Jan. 5, 1901. No. 38591.

GOLD AND SILVER.

Alluvial Mining.

Deep Alluvial Mining. D. H. Browne Practical hints. 3800 w. Aust Min Stand—Dec. 6, 1900. No. 38780 B.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. The first of a series of papers dealing with Western Australia. Treats of the history, position and general features of the districts. 4500 w. Engineering Magazine—Feb., 1901. No. 38980 B.

Chlorination.

The Chlorination of Gold Ores at Mount Morgan, Queensland. Ernest Willoughby Nardin. Abstract of a paper read before the Inst of Civ Engs in London. Describes the Hall-Richard process, which consists in subjecting the ore to the action of a solution of chlorine gas in water. 2200 w. Eng & Min Jour—Jan. 19, 1901. No. 38842.

Cripple Creek.

Cripple Creek. Arthur Lakes. Illustrated description of the volcanic formation and the present condition of the world's greatest gold-mining camp. 4800 w. Mines & Min—Jan., 1901. No. 38477 C.

Dredging.

Gold Dredging in California. Thomas J. Barbour. Abstract of a report made to the California State Miners' Asso. Reviews the work in dredging of various companies with a schedule as to what may be expected, showing the possibilities of gold dredging. 3000 w. Eng & Min Jour—Jan. 26, 1901. No. 39022.

Notes on Gold-Dredging in New Zealand. A. C. Perkins. Read at meeting of the N. S. W. Chamber of Mines. The early dredges used are described and the improvements noted; also the manner of working, and the cost per cu. yd. 2800 w. N Z Mines Rec—Nov. 16, 1900. No. 38767 B.

The Efficiency of Gold-Saving Appliances on Dredges. J. B. Smith. Discusses the losses and improvements needed, and the importance of a skillful winchman. 1000 w. N Z Miners Rec—Nov. 16, 1900. No. 38769 B.

Elevators.

Hydraulic Gravel Elevators. Illustrated description of a complete hydraulic gravel eliminating plant at the Cariboo Goldfields, B. C. 900 w. Aust Min Stand—Nov. 22, 1900. No. 38467 B.

Georgia.

Gold Mining Developments in Georgia. Wilbur Colvin. Describes and illustrates what is at present the largest gold-mill of the Dahlonega gold belt. 2000 w. Eng & Min Jour—Jan. 26, 1901. No. 39021.

Gold.

The Metallurgy of Gold (La Metallurgie de l'Or). C. Grollet. A general review of the present state of the art, as shown at the Exposition of 1900. 3500 w. Revue Technique—Jan. 10, 1901. No. 38914 D.

Gold Mining.

Ralston Divide, Placer County, Cal. A. Bordeaux. Information regarding the work done in this gold-mining property during the last two years. Ill. 1600 w. Min & Sci Pr—Dec. 29, 1900. No. 38530.

The American Nettie. Arthur Lakes. An illustrated description of a mine furnishing an example of the peculiar cave deposits and the method of mining them, near Ouray, Colorado. 3000 w. Mines & Min—Jan., 1901. No. 38470 C.

Gravel Bars.

Gold in Snake River Gravel Bars. William H. Washburn. Reports investigations made from a point about 20 miles below Huntington, Ore., to 50 miles above Ontario. 1000 w. Min & Sci Pr—Dec. 29, 1900. No. 38531.

Ore Treatment.

Treating Non-Smelting Ores in South America. Describes the methods of treating silver ores in use in South America. 1400 w. Min & Sci Pr—Jan. 5, 1901. No. 38689.

Production.

Gold and Silver in 1900. A close estimate of the gold production of the world for the year 1900. Special reports of these metals from various districts are given. 10400 w. Eng & Min Jour—Jan. 5, 1901. No. 38592.

Rock-Scraper.

Ridland's Patent Pneumatic Rock-Scraper. J. A. Miller. Illustrated description of a machine designed for getting gold out of a hard crevassy rock. Its operation is also explained. 1200 w. N Z Mines Rec—Nov. 16, 1900. No. 38768 B.

Silver District.

The Bora Creek Silver District, New South Wales. An account of this new district, which seems to be an important one, and of the development of the Conrad mine. 1100 w. Eng & Min Jour—Jan. 26, 1901. No. 39023.

Slimes.

The Agitation Process for Cyaniding Slimes. Charles S. Hurter. Describes a process whereby 80 per cent. of the total values of gold and silver in the slimes are recovered at a cost not exceeding $1 a ton. Ill. 900 w. Eng & Min Jour—Jan. 19, 1901. No. 38841.

Stamp Milling.

Stamp Milling of Free Gold Ores. Dana Harmon. A discussion of the fundamental principles to be followed. Ill. 7000 w. Jour Assn of Engng Socs—Dec., 1900. No. 38821 C.

Victoria.

Mining at Moliagul (V.). Stanley B. Hunter. Information concerning the locality where the "welcome stranger" nugget was found—the largest and most valuable mass of gold yet unearthed in any part of the world. 1700 w. Aust Min Stand—Dec. 6, 1900. No. 38781 B.

IRON AND STEEL.

Armour Plates.

Armour-Plates at the Paris Exhibiton. M. Baclé. A general review of the exhibits. 2500 w. Engng—Jan. 18, 1901. Serial. 1st part. No. 39040 A.

Blast Furnaces.

A Century of Blast Furnace Practice. Walter Kennedy. A brief description of the three classes of furnaces used in the United States and the methods employed in each; also reviewing the Chinese system of producing iron, which is the most ancient practice known. Ill. 4000 w. Am Mfr—Jan. 3, 1901. No. 38579.

Canada.

The Development of Iron and Steel Industries in Eastern Canada. J. Steven Barrie. Read at the West of Scotland Iron & Steel Inst. An illustrated account of these industries, the ore deposits and manufacture. 5700 w. Ir & Coal Trds Rev—Jan. 18, 1901. No. 39050 A.

Germany.

The German Iron Industry in the Year 1900. Emile Schrodter. A review of the production and trade. 2300 w. Ir & Coal Trds Rev—Jan. 11, 1901. No. 38804 A.

Iron Trade.

Some Controlling Features of the Iron and Steel Trade in 1900. Reviews the production, consumption, prices, and other

features. 2200 w. Ir & Coal Trds Rev—Dec. 28, 1900. No. 38614 A.

The Chicago Iron Trade in 1900. George W. Cope. A general review of conditions, prices, trade, etc. 5000 w. Ir Age—Jan. 3, 1901. No. 38488.

The English Engineering and Iron Trades. The annual review issued by Bolling & Lowe, of London. 3000 w. Ir Age—Jan. 3, 1901. No. 38490.

The Philadelphia Iron Trade. Thomas Hobson. Annual review of new plants and enlargements. 3400 w. Ir Age—Jan. 3, 1900. No. 38491.

The Pittsburg Iron Trade in 1900. Robert W. Walker. Reviews the general features of the year, the labor troubles, new construction, foreign trade, etc., and the outlook. 13500 w. Ir Age—Jan. 3, 1901. No. 38489.

The Situation in the Iron Trade of Europe. J. Stephen Jeans. A review of the last year and a statement of the present condition of the trade, and the effect of American competition. Ir Age—Jan. 24, 1901. No. 38844.

Lake Superior.

First Half-Century of Lake Superior Ore Mining. Horace J. Stevens. Reviews the history of this region, the present condition and future outlook. 2800 w. Am Mfr—Jan. 3, 1901. No. 38580.

The Lake Iron Ore Industry. Dwight E. Woodbridge. Reviews the past year, and considers the outlook for the future. 4500 w. Ir Age—Jan. 3, 1900. No. 38493.

Open-Hearth.

On New Designs of Open-Hearth Furnaces for the Manufacture of Ingot Iron. R. M. Daelen and L. Pszezolka. Comments on various designs and investigates the merits of the Talbot process. 3300 w. Ir & Coal Trds Rev—Jan. 11, 1901. No. 38805 A.

Production.

Iron and Steel in 1900. Approximate estimate. 9200 w. Eng & Min Jour—Jan. 5, 1901. No. 38593.

Rails.

The McKenna Process of Renewing Old Steel Rails. An illustrated detailed description of a process which converts them into practically new rails of perfect section and of but slightly decreased weight. 3000 w. Ir Age—Jan. 17, 1901. No. 38752.

Slag.

Blast Furnace Slag for Fertilizing. Alexander D. Elbers. On the value of this material and the way of preparing it for use. 900 w. Am Mfr—Jan. 3, 1901. No. 38582.

Steel.

Development of Steel Manufacture in the United States. Extract from article by Andrew Carnegie in the *N. Y. Evening Post*. 2000 w. Ir Trd Rev—Jan. 24, 1901. No. 38891.

The Effect of Annealing Upon the Physical Properties, and the Microstructure of a Low Carbon Steel. Henry Fay and Stephen Badlam. An account of experimental investigations, with discussion of results. Ill. 0800 w. Tech Quar—Dec., 1900. No. 38770 E.

The Kernohan Steel Process. R. B. Kernohan. Illustrated description of a new method, intended to overcome some of the difficulties of the duplex process. 1800 w. Ir Age—Jan. 31, 1901. No. 39055.

Sweden.

The Swedish Iron and Steel, Metal, and Coal Industries. Report for the year 1899. 2200 w. Engr, Lond—Jan. 18, 1901. No. 39037 A.

Tin-Plate.

Review of the Tin-Plate Industry in 1900. Charles Lancaster. An interesting review of the present position of the trade, and the effect of American competition on British trade, giving detailed information of cost, production, etc. 4000 w. Ir & Coal Trds Rev—Jan. 11, 1901. No. 38806 A.

The Welsh Tin-Plate in 1900. Review of the year. 1900 w. Col Guard—Jan. 11, 1901. No. 38828 A.

MINING.

Address.

The Future of Mining. Nelson P. Hulst. Extract from an address delivered before the graduating class of the Michigan College of Mines, on the opportunities and future outlook for mining students. 5500 w. Mines & Min—Jan., 1901. No. 38471 C.

Concrete.

Use of Concrete in Mining. Marcel Habets. From a communication to the Soc. des Ing. de Liege. On its adaptability for lining shafts and drifts, and for making stoppings, illustrating the methods of putting it in place. 2200 w. Mines & Min—Jan., 1901. No. 38474 C.

Electric Power.

Electrical Apparatus in Coal Mining. John Price Jackson. A description of the most important machinery for electric locomotion, cutters and drills. 8000 w. Jour Fr Inst—Jan., 1901. No. 38657 D.

Notes on Electrical Development and Experience in the Cripple Creek District, Colorado. J. R. Cravath. An account of the uses to which electricity is applied, the companies supplying the power, etc. 4300 w. Elec Wld & Engr—Jan. 19, 1901 No. 38813.

Hoisting.

The Treatment of Flat Hoisting Cables. A. E. Johnson. Points that must receive attention to get good service from a flat rope in mine work. 1100 w. Min & Sci Pr—Jan. 12, 1901. No. 38759.

Igniter.

Firing Blasting Charges by Induction Sparks. J. von Lauer. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrated description of apparatus designed by the writer, and the results of experiments made. 1500 w. Col Guard—Dec. 28, 1900. No. 38610 A.

Induction Spark Igniter for Mining (Funkeninductions-Minenzündung). Johann von Lauer. Illustrating and describing a convenient form of igniter for mining explosives. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 15, 1900. No. 38951 B.

Mining Lamps.

Lamp-Testing Apparatus at the Johann Shaft, Karwin. L. Volf, in *Oesterreichische Zeitshcrift für Berg und Hüttenwesen.* Illustrates and describes an apparatus so arranged that the lamps can be tested in vertical, up-hill and down-hill draughts. 2400 w. Col Guard—Jan. 11, 1901. No. 38829 A.

Lamp-Testing Apparatus at the Johann Mine at Karwin (Moravia). Showing the very complete arangement of reservoirs and measuring devices in use for observing the behavior of safety lamps in the presence of mine gases. 3500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 5, 1901. No. 38954 B.

Philippines.

Mining in the Philippines. Information relating to the present condition of mining in the Islands, with notes on the deposits, the transportation facilities, materials needed, etc. 2600 w. Min & Sci Pr—Jan. 19, 1901. No. 38867.

Mining Machinery for the Philippines. On the demand for American machinery and equipments, with brief account of Spanish and native forms in use. 2200 w. Eng & Min Jour—Jan. 19, 1901. No. 38840.

Shaft-Sinking.

The Sinking of a Shaft at the Maria Mine, Near Aix-la-Chapelle, by the Freezing Process (Das Abteufen eines Schachtes Mittelst des Gefrierverfahrens auf Mariagrube bei Aachen). H. Stegemann. By the use of freezing apparatus a ventilating shaft 130 ft. was successfully sunk through sand. 2500 w. 1 plate. Glückauf —Jan. 5, 1901. No. 38956 B.

Strikes.

The Illinois Coal Operators' Plan for Removing the Occasion of Strikes. Herman Justi. How the plan originated and the method of accomplishing its object. 4000 w. Mines & Min—Jan., 1901. No. 38473 C.

Ventilation.

The Ventilation of Preliminary Workings in Gaseous Mines (Die Bewetterung der Vorrichtungsbetriebe in Schlagwetter-Gruben). F. Pospisil. A discussion of the paper of M. Petit, presented at the Mining Congress at Paris. Two articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 5, 12, 1901. No. 38953 each B.

Winding.

Prevention of Overwinding at the Saint-Etienne Collieries, France. Illustrates and describes safety appliances in use and their operation. 1500 w. Col Guard—Jan. 11, 1901. No. 38825 A.

Weight of Winding-Drums for Deep Shafts. Daniel Burns. Discusses the mechanics of the question so far as it applies to the weight of the winding-drum. Ill. 1200 w. Trans Min Inst of Scotland —Vol. XXII., Part I. No. 38599 D.

MISCELLANY.

Aluminum.

The Prospects of the Aluminum Industry. F. H. Leeds. Reviews the position of the aluminum trade, the method of winning it and the uses to which it is put, and how the industry is likely to develop. 3200 w. Elec Rev, Lond—Jan. 11, 1901. No. 38798 A.

Graphite.

Graphite. Malcolm McNaughton. Briefly describes the formation, occurrence, sources and amount of supply, and the various uses. 5000 w. Stevens Ind—Jan., 1901. No. 38886 D.

Nickel.

Nickel Industries of Canada. Information concerning the deposits, working, etc. 800 w. U. S. Cons. Repts, No. 932—Jan. 11, 1901. No. 38625 D.

Paris Exposition.

Some Metallurgical Features of the Paris Exposition. Joseph W. Richards. Describes briefly the minerals and metals shown in various forms by the different countries. 3000 w. Mines & Min—Jan., 1901. No. 38476 C.

Petroleum.

Petroleum in 1900. A review of the production. 1700 w. Eng & Min Jour—Jan. 5, 1901. No. 38595.

Submarine Oil Wells in California. W. G. Young. Brief account of the Summerland Field, where wells are sunk in the bed of the ocean. 1000 w. Eng & Min Jour—Jan. 12, 1901. No. 38685.

The New Texas Oil Fields. Illustrates the Lucas oil well, near Beaumont, Tex.

with an account of the recent discovery. 800 w. Eng & Min Jour—Jan. 26, 1901. No. 39019.

The Petroleum Industry of the Philippines. G. D. Rice. An account of the oil-producing regions, the deposits, manner of working, etc. 2800 w. Am Gas Lgt Jour—Jan. 21, 1901. No. 38823.

Production.

The Mineral and Metal Output of the United States in 1900. A preliminary estimate of the production of the more important minerals and metals. 3800 w. Eng & Min Jour—Jan. 5, 1901. No. 38590.

Tin.

Sources of Tin Supply. Discusses the position of tin in the market, and the need of readjusting the balance. Reviews the principal supplies and conditions affecting the output. 1700 w. Engr, Lond—Jan. 4, 1901. No. 38737 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in November. Detailed list and classified summary. 4800 w. R R Gaz—Jan. 4, 1901. No. 38560.

Car Ferries.

American Car Ferries. Waldon Fawcett. Illustrations and information concerning the efficient car ferries on the Great Lakes. 1500 w. Sci Am—Jan. 19, 1901. No. 38758.

Derailments.

Derailments and Conclusions to Be Drawn Therefrom. W. H. Elliott. Condensed paper read before the Ry. Sig. Club, at Chicago. 2000 w. R R Gaz—Jan. 11, 1901. No. 38655.

Frictional Effect.

Frictional Effect of Railway Trains Upon the Air. Francis E. Nipper. Reports a series of experiments bearing on this subject. Ill. 2300 w. Ry & Engng Rev—Jan. 26, 1901. No. 39049.

High Speed.

Fast Runs. Tabulated statement of fast and unusual runs made during 1897-1900. 500 w. R R Gaz—Jan. 11, 1901. No. 38654.

The Question of the Cost of High-Speed Trains. C. Rous-Marten. Showing that the advantages of high speed cause it to be a profitable practice; rapid transportation being the counterpart to intensified production. 4500 w. Engineering Magazine—Feb., 1901. No. 38-979 B.

Long Run.

A Run from Adelaide to Sydney. Describes the train and run of 1,059 miles. 2700 w. Engr, Lond—Dec. 28, 1900. No. 38619 A.

Northern Pacific.

The First Time Card on the Northern Pacific. A facsimile of this interesting time card, with reminiscent notes concerning the early days on the Northern Pacific, by George W. Cushing. 1800 w. Ry Mas Mech—Jan., 1901. No. 38637.

Supervision.

Some Ideas on Road Supervision. Eugene M'Auliffe. Discusses economics in the mechanical and operating departments. 2000 w. Loc Engng—Jan., 1901. No. 38526 C.

Telephones.

Telephone Train Despatching. On the adaptability of telephones to this work, precautions necessary, and the reason why so little used. 1300 w. R R Gaz—Jan. 4, 1901. No. 38559.

Train Service.

British and French Train Services in 1900. Charles Rous-Marten. Reviews the last year, the long runs, fast runs and general service in both countries. 4800 w. Engr, Lond—Jan. 11, 1901. No. 38808 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Repairs on Air Brakes on Box Cars. H. H. Harvey. Read at Chicago meeting of the Car Foremen's Assn. Describes methods of handling triple valve repairs in the most economical way. Ill. 2000 w. Ry Mas Mech—Jan., 1901. No. 38638.

Skipping Tests of Air Brakes. Richard A. Smart. Describes tests made to secure information as to the conditions under which the emergency feature of the quick action air-brake will skip cut-out cars. 900 w. R R Digest—Jan., 1901. No. 38773.

Bearings.

Middle Bearings on Driving Axles. N. Y., O. & W. Ry. Illustrates and describes the details of an adaptation devised by George W. West, to relieve the boxes at the sides of a portion of the weight. 450 w. Ry & Engng Rev—Jan. 19, 1901. No. 38849.

Buffers.

The Computation of Evolute Springs

(Die Berechnung der Evolutfeder). Victor Meyer. Developing formulæ and tables for use in proportioning evolute spiral springs such as are used for buffers for railway carriages. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 29, 1900. No. 38922 D.

Center Plates.

Center Plates. Edward Grafstrom. Considers the suggestions contained in the report of the committee of the M. C. B. Assn. Ill. 1500 w. Am Engr & R R Jour—Jan., 1901. No. 38513 C.

Equipment.

Four-Wheel Steel Frame Truck and Steel Frame Draft Gear. Drawings and description. 700 w. Am Engr & R R Jour—Jan., 1901. No. 38516 C.

Feed Water.

Water Softening Plant of the Cincinnati, Hamilton & Dayton Railway. Illustrated description of the plant with report of cost of operating. 900 w. R R Gaz—Jan. 4, 1901. No. 38558.

Fire-Boxes.

The Causes of Rapid Wear and Tear of Fire-Boxes of Locomotives. Robert Weatherburn. Discusses the causes of deterioration, and suggests ways of obviating some of the troubles. 4300 w. Engr, Lond—Dec. 28, 1900. No. 38617 A.

Fuel.

Oil as Locomotive Fuel in California. An account of the use of this fuel on the roads of California, and illustrated description of the oil-handling arrangements at Los Angeles. 1800 w. Ry Age—Dec. 28, 1900. No. 38494.

Gondola Car.

Low Drop-Bottom Gondola Car, 80,000 Lbs. Capacity. Illustrates and describes a design approved for adoption on the Chicago & Northwestern and allied lines. 300 w. Am Engr & R R Jour—Jan., 1901. No. 38515 C.

Locomotive Construction.

Locomotive Boilers Free From Strains (Der Spannungsfreie Locomotivkessel). H. Lentz. A paper before the German Railway Society, discussing a form of suspension for locomotive boilers by which distorting strains may be avoided. Cast frames are also discussed. 3000 w. Glaser's Annalen—Jan. 15, 1901. No. 38935 D.

Locomotives.

European Express Locomotives. Frank C. Perkins. Illustrated descriptions of designs now in use on French, English and German railways. 1200 w. R R Digest—Jan., 1901. No. 38774.

German Express Locomotive with Auxiliary Driving Axle. Frank C. Perkins. Illustrated detailed description of a recently constructed express locomotive exhibited at the Paris Exposition. 1500 w. Sci Am—Jan. 26, 1901. No. 38870.

German Locomotives at the Paris Exhibition. Illustrates and describes the exhibit of the Hanover Engine Construction Company. 800 w. Engng—Jan. 18, 1901. No. 39042 A.

Heavy Ten-Wheel Compound Passenger Locomotives with Wide Fire-Box—Lehigh Valley Railroad. An illustrated detailed description of an advanced design, with general dimensions, and inset. 1200 w. R R Gaz—Dec. 28, 1900. No. 38508.

New "Empire State Express" Locomotive. Brief illustrated description of an 8-wheel engine for fast service. 300 w. Am Engr & R R Jour—Jan., 1901. No. 38514 C.

Locomotives and Cars at the Exposition of 1900 (Die Weltausstellung in Paris, 1900. Lokomotiven und Wagen). E. Brückmann. A general review of the exhibits at Vincennes. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 15, 1900. No. 38915 D.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. An account of the Mallet system of compound articulated locomotives in connection with the exhibit of Maffei, of Munich. 2000 w. 1 plate. Génie Civil—Jan. 5, 1901. No. 38906 D.

Locomotives at the Paris Exposition, 1900 (Die Lokomotiven der Pariser Weltausstellung, 1900). S. Fraenkel. The beginning of an exhaustive review of the exhibits at Vincennes. with tabular view of the various engines, giving data as to dimensions and performance. Serial. Part I. 2000 w. 1 plate. Glaser's Annalen—Jan. 1, 1901. No. 38930 D.

Notes on the Locomotives Exhibited at Paris, 1900 (Quelques Observations Relatives aux Locomotives à l'Exposition de 1900). A general review of the exhibited engines, with regard to economy, design, and novelty. 3000 w. Revue Technique —Dec. 25, 1900. No. 38911 D.

Paris Exhibition.—Express Engine, Saxony State Railways. Illustrated detailed description. 1000 w. Engr, Lond —Jan. 18, 1901. Serial. 1st part. No. 39035 A.

Progress of Two-Cylinder Compound Locomotives During the Past Ten Years. C. J. Mellin. Reviews the progress in its evolution to the present state, and states its advantages over the simple engine. 3000 w. R R Gaz—Jan. 25, 1901. No. 38894.

Richmond Ten-Wheeler of Atlantic Coast Line. Illustration and dimensions. 300 w. Loc Engng—Jan., 1901. No. 38527 C.

Some Ten-Wheel Passenger Locomo-

tives—Atchison, Topeka & Santa Fe. Illustrated description of engines listed under the general head of Class B. 2000 w. R R Gaz—Jan. 18, 1901. No. 38778.

Ten-Wheel Passenger Locomotives—Atchison, Topeka & Santa Fe, Class B-15. Illustrated detailed description, with general specifications. 1500 w. R R Gaz—Jan. 25, 1901. No. 38892.

The Early Locomotives and Their Builders. Herman L. Morse. Describes the methods and appliances used by the builders of fifty years ago. 1700 w. Loc Engng—Jan., 1901. No. 38528 C.

The Paris Exhibition.—Express Engine with Auxiliary Driving Gear. An illustrated detailed description of this interesting engine with explanation of its operation. 1700 w. Engr, Lond—Jan. 4, 1901. No. 38736 A.

Vauclain Compound Consolidation Locomotives. Illustrated description of engines for the Union Pacific Ry. 400 w. Am Engr & R R Jour—Jan., 1901. No. 38517 C.

Wide Fire-Box, Atlantic Type, Locomotive-Baltimore & Ohio Railroad. Illustrations and general dimensions. 500 w. R R Gaz—Jan. 11, 1901. No. 38653.

Lubrication.

Effective Lubrication of Driving Boxes. Illustrates and describes methods in use, and thinks that in common practice too little motion is allowed. 1400 w. Am Engr & R R Jour—Jan., 1901. No. 38512 C.

Steel Cars.

Structural Steel Flat Car. Illustrated detailed description of specially designed very long cars. 1000 w. Ry & Engng Rev—Jan. 26, 1901. No. 39047.

The Design of Structural Steel Cars. George I. King. Gives standard specifications for freight car equipment of this type, calling attention to unusual features. Ill. 1700 w. R R Gaz—Jan. 4, 1901. No. 38557.

The Large Steel Car. W. S. Morris. Discusses its development and position in the business of railroads. 4000 w. Am Engr & R R Jour—Jan., 1901. No. 38511 C.

The L. M. Slack Steel Cars. Illustrated description of types of gondola cars recently designed. 1500 w. R R Gaz—Jan. 18, 1901. No. 38777.

Train Lighting.

See Electrical Engineering, Lighting.

Train Lighting from the Car Axle. Reviews the history of train lighting, from the beginning, when penny candles were used, and describes the Consolidation Axle Light system. Ill. 1400 w. Sci Am—Jan. 26, 1901. No. 38871.

Wheels.

Steel Wheels. Illustrates and describes the manufacture of such wheels. 800 w. Am Mach—Jan. 3, 1901. Serial. 1st part. No. 38543.

NEW PROJECTS.

British Columbia.

Proposed Railroads in British Columbia. Concerning a proposed road to be known as the Victoria-Vancouver and Eastern Railway and Navigation Company. 700 w. U. S. Cons Repts, No. 940—Jan. 21, 1901. No. 38795 D.

Cuba.

Railroads in Cuba. Editorial on the importance of railroad facilities for the island, and discussion of the legal situation, and the plan in progress. 900 w. R R Gaz—Jan. 25, 1901. No. 38895.

Guatemala.

Guatemalan Railway Contract. Translation of a contract between the Government of Guatemala and the Central American Improvement Company, summarizing the principal articles. 900 w. U. S. Cons Repts, No. 940—Jan. 21, 1901. No. 38796 D.

Nicaragua.

Railway Contract in Nicaragua. Summary of the contract to construct a railroad from Managua to La Paz. 1000 w. U. S. Cons Repts, No. 928—Jan. 7, 1901. No. 38523 D.

Reconstruction.

The Reconstruction of the Utah Central Railway. W. P. Hardesty. An illustrated description of the newly constructed line between Salt Lake City and Park City at a cost of $400,000. 3000 w. Eng News—Jan. 17, 1901. No. 38784.

PERMANENT WAY AND BUILDINGS.

Block System.

Length of American Railroads Worked by the Block System. A summary of miles of railroad in the United States worked by the block system. 3500 w. R R Gaz—Jan. 11, 1901. No. 38652.

Depot.

Tile Depot and Freight House, A. & W. R. R. Illustrated description of new building erected at Ashland, Ohio. 600 w. Ry & Engng Rev—Jan. 19, 1901. No. 38848.

France.

The Eastern Railway of France (Compagnie des Chemins de Fer de l'Est). An account of the permanent way exhibit of this road at Paris, including roadbed, rails, signals, etc., etc. 8000 w. 22 plates. Rev Gen des Chemins de Fer—Dec., 1900. No. 38942 H.

Freight Yards.

Method of Procedure in Remodeling Freight Yards. W. C. Cushing. A dis-

cussion of the general principles governing yard design and operation, illustrated by plans. 4500 w. R R Gaz—Jan. 4, 1901. No. 38556.

Greece.

Railway Construction in Greece. H. L. Geissel. Describes proposed extensions delayed by the South African War. 700 w. Eng News—Jan. 10, 1901. No. 38648.

Rails.

The Wear of Rails in Tunnels. Thomas Andrews. Read before the Inst. of Civ. Engs. Reports results of an examination of a rail which had done service in such a situation, and discusses the subject generally. 3000 w. R R Gaz—Dec. 28, 1900. No. 38510.

Roundhouses.

A Modern Roundhouse. Illustrated detailed description of a thoroughly equipped roundhouse plant for the Chicago & Northwestern Ry., at Clinton, Ia. 1000 w. Am Engr & R R Jour—Jan., 1900. No. 38518 C.

Heating System of the Clinton, Ia., Roundhouse. Illustrated description of an admirable arrangement, and a statement of its advantages. 700 w. R R Gaz—Dec. 28, 1900. No. 38509.

Shops.

New Shops of the Wisconsin Central at Fond du Lac. General and detail plans of new repair shops, with illustrations and description. 1800 w. Ry & Eng Rev—Jan. 19, 1901. No. 38847.

Signaling.

A Description of the Present Method of Signaling Trains Through the St. Louis Tunnel. M. Wuerpel, Jr. Gives a short history of the traffic and earlier attempts at signaling, with illustrated detailed description of the system now in use. 5500 w. St. Louis Ry Club—Jan. 11, 1901. No. 39044.

A Simple Railway Signal System. E. C. Parham. Describes a signal system for use on single-track trolley roads. Ill 1200 w. Am Elect'n—Jan., 1901. No. 38632.

Automatic Block Signals on the Fort Wayne. Illustrates and describes the arrangement of signals from Allegheny City, Pa., to Homewood, on a busy suburban line. 3700 w. R R Gaz—Jan. 18, 1901. No. 38779.

Spring Plant.

The Pennsylvania Railroad's Spring Plant at Altoona. Illustrates several of the machines used, and gives description of their operation. 3500 w. R R Gaz—Jan. 25, 1901. No. 38893.

Station.

Great Central Railway.—Victoria Station, Nottingham. Illustrated description of a fine joint station. 1200 w. Engr, Lond—Jan. 18, 1901. Serial. 1st part. No. 39038 A.

Tunneling.

See Civil Engineering, Construction.

TRAFFIC.

Rebates.

Freight Rebates in England. Extract from the London *Mail*, concerning a rebate agreement by the Midland Ry. and the consequences. 700 w. U. S. Cons Repts, No. 938—Jan. 18, 1901. No. 38766 D.

Trans-Siberian.

The Trans-Siberian Railway (Le Chemin-de-Fer Trans-Sibérien). G. de Krivochapkine. Especially devoted to the economic influence of the railway upon the mineral industries of Siberia and upon international commerce. Two articles, 6000 w. Génie Civil—Dec. 15, 22, 1900. No. 38900 each D.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Electric Traction on the Berlin City and Belt Line (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). D. Pforr. A comparison of electric with steam traction under similar conditions. 4000 w. Glaser's Annalen—Dec. 15, 1900. No. 38929 D.

Compressed Air.

The Compressed Air Motor in Street Car Service. A review of 28th and 29th sts. line in New York. An official statement of the running of the cars. 1900 w. Compressed Air—Jan., 1901. No. 38576.

Consolidations.

Consolidations of Street Railways. H. H. Vreeland. Discusses the benefits to the public and to employees, and gives interesting information. 1300 w. St Ry Rev—Jan. 15, 1901. No. 38850 C.

Development.

Development of Electric Traction. Frank B. Rae. Brief review from the first application of the magnetic motor to the propulsion of a car. 1600 w. W Elect'n—Jan. 5, 1901. No. 38663.

Economies.

Economies in the Installation of Electric Tramway Plant. W. H. Booth. Discusses things to be considered in designing a plant. 1900 w. Elec Rev, Lond—Jan. 18, 1901. No. 38897 A.

Electric Traction.

A Résumé of the Electric Street Railway. O. T. Crosby. Reviews the advantages and benefits to the public due to this enterprise. Ill. 3500 w. St Ry Jour—Jan. 5, 1901. No. 38585 D.

Electrolysis.

A Court Decision as to Responsibility for Damage by Electrolysis to Gas Mains. Gives a decision rendered at Indianapolis, Ind., that may prove of great importance. 1300 w. Eng News—Jan. 3, 1901. No. 38550.

Electrolysis. Albert B. Herrick. Gives the history of subterranean electrolysis, explaining the cause and effect, and means employed to reduce the trouble to a minimum. 2000 w. St Ry Rev—Jan. 15, 1901. No. 38854 C.

English Law.

Law of Deep Tunnel Railways. Discusses complaints made by occupiers of houses along the route, and the attitude of English law. 2400 w. Engng—Jan. 4, 1901. No. 38732 A.

Feeders.

The Supply of Current to Long Tramway Lines (Ueber Stromversorgung Längerer Bahnlinien). Dr. G. Rasch A discussion of various feeder systems for tramway lines, including separate main stations, sub-stations, and alternating current supply. Two articles, 10000 w. Elektrotech Zeitschr—Dec. 20, 27, 1900. No. 38958 each B.

Future.

The Electric Railway of the Future—A Prophecy. Louis Bell. Reviews the general outlook for electric traction. 4000 w. St Ry Jour—Jan. 5, 1901. No. 38586 D.

The Future of the Electric Railway. B. A. Behrend and A. G. Wessling. A sketch containing many suggestions worthy of thought. 2500 w. Elec Wld & Engr—Jan. 12, 1901. No. 38683.

Generators.

Development of the Modern Railway Generator. Historical review, giving illustrations of many types. 4200 w. St Ry Rev—Jan. 15, 1901. No. 38853 C.

Heavy Service

Electric Traction for Heavy Railway Service. Edward P. Burch. Read before the Northwest Ry. Club. Shows the present standing of electric-railway engineering, and gives reasons why electric motive power will supplant the steam locomotive for heavy service. 5000 w. St Ry Rev—Jan. 15, 1901. No. 38855 C.

History.

Historical Notes of Electric Traction. Historical review, with introductory note by Frank J. Sprague. Portraits. 6000 w. Elec Rev, N. Y.—Jan. 12, 1901. No. 38715.

Improvements.

Electric Traction in the Twentieth Century. S. H. Short. Notes some of the agreeable changes due to the introduction of electric traction, and calls attention to improvements expected. 1500 w. Elec Rev, Lond—Jan. 11, 1901. No. 38799 A.

Italy.

Electric Traction in Naples, Italy, and Vicinity. Information concerning the transformation of the horse-car lines and the system installed. 2200 w. Elec Wld & Engr—Jan. 19, 1901. No. 38814.

Manhattan Elevated Ry.

Electric Plant of the Manhattan Elevated Railway. An illustrated account of the main features of this installation. 4200 w. Elec Wld & Engr—Jan. 5, 1901. No. 38667.

The Electrical Equipment of the Manhattan Elevated Railway. A comprehensive series of articles relating to this great work in progress in New York. The magnitude of the work, the engineering problems, and special features introduced make the subject of great interest. This issue describes the generating station and distributing system in detail. Ill. 26200 w. St. Ry Rev—Jan. 5, 1901. No. 38584 D.

Multiple-Unit.

The Sprague Multiple-Unit Railway System. Edw. Chilton. Discusses the objections to the multiple-unit train system, and gives illustrated description of manner of controlling used in the Sprague system. 2200 w. Am Elect'n—Jan., 1901. No. 38634.

Narrow Gauge.

The Electric Narrow-Gauge Road in the Clausthal District (Die Elektrische Schmalspurbahn der Königlichen Berginspection Clausthal). Dr. J. Werther. Describing a successful electric mining road in the Harz. 1200 w. Stahl und Eisen—Dec. 15, 1901. No. 38937 D.

Newfoundland.

The St. John's Street Railway. An illustrated description of interesting features of a road built where many topographical difficulties were encountered. 700 w. St Ry Jour—Jan. 5, 1901. No. 38587 D.

Power Plant.

Hydraulic and Steam Power Plant of the Virginia Electrical Railway and Development Company, Richmond, Va. Illustrated description of the new central station for supplying railway power and lighting current, and the elaborate hy-

draulic works in the James River rapids. 2400 w. Elec Rev, N. Y.—Jan. 26, 1901. No. 38876.

Power Station.

The Railway Power Station. Reviews the progress and development of the last ten years, and the various systems, and equipment. 4000 w. St Ry Rev—Jan. 15, 1901. No. 38852 C.

Progress.

Electric Tramways—Progress in the United Kingdom, 1891-1900. J. Clifton Robinson. A résumé of the history of tramways in Gt. Britain and Ireland during the last ten years. 5000 w. St Ry Rev—Jan. 15, 1901. No. 38851 C.

Railway Motors.

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Electric Traction and Transmission in the New Century. Philip Dawson. Gives a retrospect of the progress in England during the last 10 years, discusses the present position of the electrical industries, and the future outlook. 3500 w. Elec Rev, Lond—Jan. 4, 1901. No. 38700 A.

Southampton, Eng.

Southampton Corporation Electric Tramway and Lighting System. H. G. Nicholson. The electricity works were formerly for lighting purposes only, and how they have been adopted for supplying the necessary power for tramways is illustrated and described. 2400 w. Elect'n, Lond—Jan. 11, 1901. Serial. 1st part. No. 38845 A.

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The Possibilities of a State Electric Freight Railway as a Substitute for a Barge Canal from Buffalo to the Hudson River. J. H. Ehrehart. A letter considering this subject. 1400 w. Eng News—Jan. 17, 1901. No. 38786.

Storage Batteries.

Influence of Storage Batteries Upon Railway Generating Apparatus. R. C. Hull. Showing how faithfully the storage battery can be made to perform its duty, and their use as applied to railway operation. 1600 w. Elec Rev, N. Y.—Jan. 19, 1901. No. 38782.

Tramways.

Tramways in Large Cities. C. H. Wordingham. Reviews the probable effects of the extensive network of tramways, destined to cover Gt. Britain, and some of the problems involved. 2700 w. Elec Rev, Lond—Jan. 18, 1901. No. 38896 A.